PREDICTING BURIED SITES: ANALYSIS OF THE TIPTON TILL PLAIN REGION OF INDIANA.

A THESIS

SUBMITTED TO THE GRADUATE SCHOOL

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE

MASTER OF ARTS

BY

ANDREW M. SMITH

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BALL STATE UNIVERSITY

MUNCIE, INDIANA

JULY 2010

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Abstract

This thesis utilizes a combination of landform and soil data and a GIS model to analyze previous subsurface reconnaissance data within the Tipton Till Plain region of Indiana. Survey areas are analyzed according to their location within drainages as well as on their individual surface and subsurface soil characteristics. Additionally, measurements of the valley width at the investigation area and upstream are collected and considered. Soils are also analyzed as a ratio of their individual impermeability in relation to the impermeability of upstream soils. Soil taxonomy and drainage characteristics are analyzed along with the effects stream order and proximity to water have on the potential for an area to contain buried deposits. The conclusion drawn is that comparisons of the permeability of individual drainage basins in relation to the larger drainage basin is not a reliable method of predicting the potential for site burial. The relationship between the valley width at the point of investigation in relation to valley width upstream was analyzed with a weak correlation between valley width stability and the potential for buried deposits. Soil drainage and taxonomic classification analysis appear to show where buried deposits are not likely to be encountered. The analyses of stream order and proximity to water did not reveal any significant differences in the potential for encountering buried deposits. It is recommended that the current guidelines for recommending subsurface investigation should be followed more strictly.

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Chapter 1. Introduction

Subsurface investigation is a site discovery technique employed in areas that have the potential to contain intact buried archaeological deposits. The methods employed to discover buried deposits can vary as can the initial determination of a landform suitable for the presence of buried deposits. This thesis will review literature from Indiana archaeological reports of subsurface investigations utilizing multiple methods of analysis to determine if the current factors for recommending subsurface investigation in the Tipton Till Plain region are justified. The common recommendation for subsurface investigation is on the basis of two factors; the presence of well drained alluvial, colluvial or aeolian deposits and the energy of sediment deposition. Limiting recommendations to these broad factors restricts the utility of predictive modeling. This thesis attempts to incorporate additional factors that can be utilized with the current method of recommendation in order to create a system more useful in determining the potential for discovering subsurface deposits and a system with testable predictions.

Archaeological site discovery and evaluation of eligibility for listing on the National Register of Historic Places is the goal of the Section 106 process, under which most archaeological work in Indiana is conducted. Analysis of sites is not limited to surface sites when subsurface deposits may also be affected by an undertaking. One problem with the process of discovering subsurface deposits is that it requires much more intensive and expensive labor than that entailed in discovering surface sites. An effort to provide all the necessary assessment required by law, without exceeding the mandate set forth in Section 106, is a difficult task. There is an ambiguity in the Secretary of the Interior's Standards for Identification in 48 FR 44720-44721 Standard I which states that "identification of historic properties is undertaken to the degree required to make decisions." In a vacuum of critical knowledge guiding a strategy for locating subsurface deposits, any justification provided for the potential for buried deposits has no counter-critique and *vice versa*; and therefore the variables required to make decisions are highly debatable. It is this vacuum that the current research seeks to fill. The focus of the research is within valleys in the Tipton Till Plain because valleys are the locus of site burial. For the purposes of this undertaking the valley was defined as the valley floor—the area of low relief immediately surrounding the stream to the edge of where county soil maps define soils of alluvial and outwash origin.

Multiple methods of analyzing the potential for areas to contain intact subsurface deposits are tested. These included predicting site burial potential on the basis of changes in valley widths, a model of soil impermeability to test whether buried sites occur more frequently in areas of permeable soils downstream from impermeable soils, an examination of soil taxonomy and drainage characteristics, the evaluation of areas based on stream order, and on an area's proximity to the water source. It was determined that the relation of upstream permeability to local permeability is not a potential method of determining an area's suitability for containing intact buried deposits. The measurement of valley width appears to demonstrate that stable valley widths upstream from a given area more likely to result in buried deposits. The analysis of soil characteristics revealed that Mollisols (prairie soils) are more likely to contain buried deposits than Inceptisols (recent soils), and areas that are well drained are much more likely to contain buried deposits. The analyses of stream order and proximity to the water source did not demonstrate any significant differences in the potential of an area to contain buried deposits.

Chapter 2. Background

Glaciation occurred in Indiana multiple times during the Pleistocene epoch. The most recent glaciation reached a maximum approximately 20,000 BP (Erickson 1996: 22). The glaciation of Indiana had profound effects on the modern topography. Glacial till covers most of the extant features in northern Indiana (Wayne 1966). This till is thick, and in most places completely masks the underlying bedrock. However, in many outwash valleys and recent river valleys water has scoured through the overlying till to the bedrock below (Wayne 1966).

The structural framework of Indiana is divided into three general areas: the Illinois and the Michigan Basins which are separated by the Cincinnati Arch and its branches of the Findlay and Wisconsin Arches (Gutshick 1966: 9). The Tipton Till Plain region of Indiana includes both the Cincinnati Arch and the Illinois Basin (Gutshick 1966: 10-17). The Cincinnati Arch and Illinois Basin can be divided into smaller physiographic units and bedrock physiographic zones (Schneider 1966: 54).

The Tipton Till Plain physiographic unit is the research universe for the current study and has been defined as a "nearly flat to gently rolling glacial plain" (Schneider 1966: 49). The Tipton Till Plain includes multiple physiographic units including the: Bluffton Plain, Scottsburg Lowland, Norman Upland, Crawford Upland, Sullivan Lowland, Muscatatuck Regional Slope and Dearborn Upland (Gray 2000).

Research Biases

There are two problems with subsurface investigation in the glaciated portions of Indiana. The first is that there is a bias, real or perceived, that the till plain regions of the state are less productive archaeologically than other regions. This sentiment is best expressed by Kellar when he stated that:

> The frequency and kinds of archaeological sites are not equally distributed throughout the state. To the contrary, the aboriginal inhabitants were tied more closely to the natural environment than we are, and site distributions in Indiana reflect the greater potential and differential resources of the several areas. For example, the broken uplands in the south-central sector and the *Tipton Till Plain in the north-central generally contain fewer and less intensively occupied sites* than the northern lake and moraine region or the Wabash Lowlands in the southwest [Kellar 1966: 489-490 emphasis added].

This bias against the potential of these areas for containing sites has remained a pervasive assumption in the archaeology of Indiana even in the face of evidence against it. From the Southwest Indiana Data Center Surveys conducted by Indiana State University, an overall site density of one site per 7.3 acres surveyed was discovered (Stafford et al. 1988). A recent grant project in Hancock County, in one of the most till plain dominated settings in the state, documented a site density of one site per 4.9 acres surveyed (McCord et al. 2007). An even greater density of sites occurs in the valleys within the Tipton Till Plain (Anuszczyk and Cochran 1984; Cochran and Buehrig 1985; Holstein and Cochran 1984; James and Cochran 1986; Kellar 1963, 1964a, 1964b; McCord 2005; Wepler 1982; Wepler and Cochran 1982, 1983a, 1983b). In a recent survey of the Upper Wabash River valley, sites occurred within the valley at a frequency of double that of the uplands with significantly higher artifact totals (Smith et al. 2009). Additionally, some research has been conducted along what have been termed underfit streams (Angst 1997; Burkett and

Hicks 1986; Smith et al. 2008). These are present day streams flowing through large sluiceway valleys carved by outwash at the end of the Pleistocene. What these studies have shown is that sites and artifacts also occur with a high frequency in these settings. The artifact and site densities are not as great as within the large river valleys, but they are not insubstantial. Within the valley the density of surface sites is particularly high on well drained soils (Smith et al. 2009). Differences in settlement systems and the pattern of site types may differ between physiographic regions in the state. However, in light of evidence to the contrary, the assumed bias of lower site densities in the till plain region of the state should be discarded.

The second problem is in some ways interdependent upon the first problem; but it also stems from additional geologically oriented biases. The problem is that an assumption of lower buried site potential exists as one moves away from the largest rivers in the state to lower stream orders. This coincides with arguments for the previously mentioned lower initial site densities in these regions. It also relies on the assumption that larger stream orders carry and deposit larger quantities of sediments than smaller stream orders.

The larger stream orders, with the available capacity of carrying a larger magnitude of sediments, are capable of burying sites more rapidly and more deeply than smaller stream orders. However, based upon the definition of a buried site, the site need not be buried deeply in order to contain intact deposits.

One assumption of the current research is that modern drainage characteristics are mirrored prehistorically. The author recognizes the flaw in the assumption. Floodplains are dynamic and can undergo dramatic changes. However, the factors contributing to an evolution from a poorly drained to well drained area involve the type of sedimentation necessary for site burial, and these areas would be recommended for subsurface investigation under current guidelines. Areas that evolve from well drained to poorly drained would undergo scouring, and would be unlikely to contain intact deposits (Figure 1). The figure below shows an idealized example of the change within a single floodplain landform. The original surface is scoured from the upstream side and deposition occurs on the downstream side. This assumption seems the most reliable assumption on which to build a probabilistic model for site discovery in the glaciated portions of Indiana.

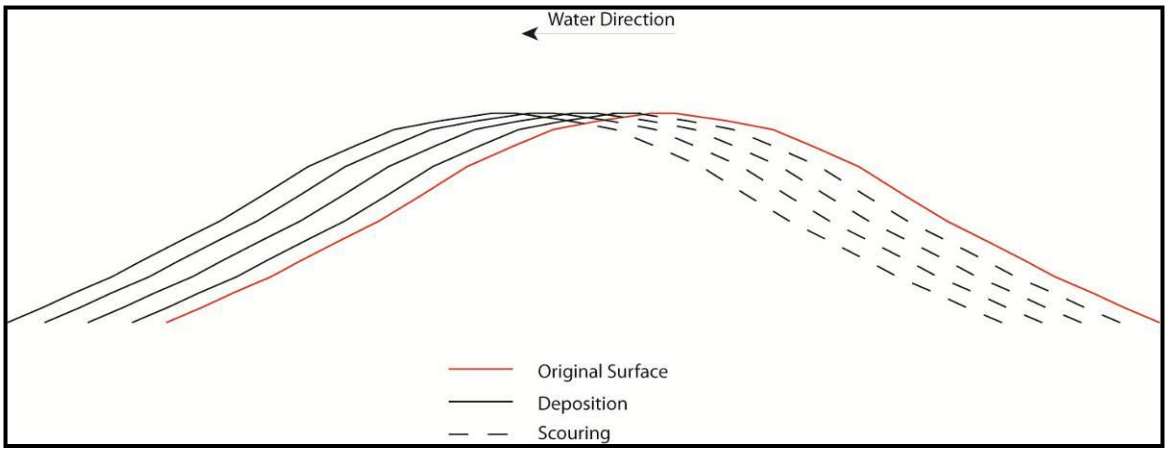

Figure 1. An idealized example of landform change over time.

There are two additional problems with the current research. The first is that it is impossible to determine whether the literature reviewed is representative of the work that has been conducted within the Tipton Till Plain. This is because it is unknown how many subsurface reconnaissance investigations have been conducted within the Tipton Till Plain. The second is that the work that has been conducted in the Tipton Till Plain has been primarily conducted under Section 106 and may not be representative of the Tipton Till Plain geologically.

The Section 106 Process

As most archaeological research conducted in Indiana is a function of the Section 106 process, it seems important to use Section 106 as the framework for guiding future subsurface research in the state. The process of Section 106 that is outlined in 36 CFR §800.4(b)(1) states that:

> The Agency Official shall make a reasonable and good faith effort to carry out appropriate identification efforts, which may include background research, consultation, oral history interviews, sample field investigation, and field survey. The Agency Official shall take into account past planning, research and studies, the magnitude and nature of the undertaking and the degree of Federal involvement, the nature and extent of potential effects on historic properties, and the likely nature and location of historic properties within the area of potential effects. The Secretary's Standards and Guidelines for Identification provide guidance on this subject.

This "good faith effort" to locate sites, especially subsurface sites, has a deliberate ambiguity to allow the investigator the flexibility to approach the situation as real world variables dictate. This ambiguity can lead to undue simplification or over-complication of the factors which affect site burial, which can contribute to an under or overuse of subsurface reconnaissance.

The Section 106 process is undertaken to identify sites and determine their National Register eligibility. The primary method of evaluating whether a site qualifies for listing on the National Register is based on whether the site provides information important in history or prehistory. The determination of whether a site provides important information is based upon how it can alter, or supplement archaeological interpretation.

Much of archaeological interpretation lies in trying to understand how cultures work systematically (Binford and Binford 1968). Settlement patterns and systems, mortuary practices, food procurement and processing, how these systems relate to other known cultural entities, and how they change over time are the primary goals of scientific archaeology (Binford and Binford 1968, Flannery 1968, Trigger 1989), and loss of information can lead to flawed interpretation.

Most of the Tipton Till Plain within Indiana has been disturbed by agriculture. In the uplands, where soil formation is slow or even erosional, surface archaeological deposits are likely to have been disturbed from their original context. While surface sites can provide significant temporal, spatial, and structural information on the prehistoric peoples of Indiana, the information is only partial. Excavations within agriculturally disturbed areas tend to locate only those features that had sufficient depth that portions of the feature remain intact below the plowzone.

The burial of a site can preserve not only individual features and artifacts contextually, but can also preserve the interrelationships between features within a site. Where surface sites can lack information on the relationships between feature classes, on sites that are buried those relationships are preserved. Buried sites can provide for a greater understanding of the specific patterns that archaeologists are most concerned with interpreting. While the methods of site burial may differ worldwide there are many examples of archaeological breakthroughs made by the discovery and excavation of buried sites from Pompeii to Troy as well as many specifically within the Eastern United States (for examples see Cantin 2010, Chapman 1973). With the amount of disturbance in the till plain region of Indiana, those sites that are buried within river valleys may be the only way to gain a holistic and systematic perspective of Native life within the region. Therefore, subsurface investigations are an integral part in understanding and evaluating sites. Subsurface investigations are conducted because "while archaeological remains occur at the surface, a significant portion of the record may be buried" (Stafford 1995: 70). Binford (1972: 156) states that "test trenches are appropriate units of excavation when one is investigating certain limited, formal properties of the site...[and]…are useful in preliminary investigations of depositional problems."

Recognizing the potential significance of buried archaeological deposits, Indiana has draft guidelines that require subsurface reconnaissance "in areas where archaeological remains are likely to be buried in alluvial, colluvial, or aeolian landforms…to find sites in both their vertical and horizontal exposures" (DHPA 1989: 9).

As the current paradigm for subsurface reconnaissance in Indiana dictates, deposits that consist of fine grained silts and clays which are of alluvial, colluvial or aeolian in derivation and are in well drained or moderately well drained soils are most often recommended for subsurface reconnaissance. The methods employed on the subsurface reconnaissance varies depending on the equipment chosen by the various researchers and the potential depth of buried deposits, but the methods are all aimed at sampling well drained, low energy alluvium for the presence or apparent absence of archaeological sites. The prehistoric settlement preference for well drained soils noted on surface sites guides the current recommendations for subsurface investigation only in well drained soils (DHPA 1989). As it has been indicated that there is a low potential for surface sites on poorly drained soils, it is inferred that poorly drained alluvial soils also would not have been selected for settlement and would be unlikely to contain buried deposits (McCord et al. 2007).

Other states, particularly Minnesota, have been proactive about the issue of subsurface investigation and have invested in determining site potentialities for different environmental zones (Commonwealth Cultural Resources Group 2006). No such effort has currently been carried out in Indiana and, therefore, there are no standardized methods of buried site identification or of determining site suitability for containing intact buried deposits. This methodological deficiency in the current research brings to mind Evans-Pritchard's rebuke on anthropology when he stated:

> Up to the present nothing even remotely resembling what are called laws in the natural sciences has been adduced—only rather naïve deterministic, teleological, and pragmatic assertions. The generalizations which have so far been attempted have, moreover, been so vague and general as to be, even if true, of little use, and they have rather easily tended to become mere tautologies and platitudes on the level of common sense deduction [Evans-Pritchard 1951: 57].

In order to become more scientific and probabilistic, the potential for buried sites cannot be evaluated on a single variable. For any scientific endeavor, Harris stated that, "in order to achieve nomothetic status these summaries…must be rephrased into the form of propositions about covariance, from which probabilistic predictions…can be made" (Harris 2001: 650).

The underlying theoretical constant in subsurface investigations is the idea of stratigraphy. This thesis research is guided by the law of stratigraphic succession (Harris 1979). It is understood that while the law of stratigraphic succession remains constant, the interpretation of stratigraphy can be problematic. Stratigraphy is "an analytical interpretation of the structure produced by the deposition of geological and/or cultural sediments into layers or strata" (Thomas in Goldberg and MacPhail 2006: 29-30). The current research also relies on the theoretical geological principle that in water sorted soils, abhorrently sized particles (including artifacts) cannot be explained by water deposition alone and require extra-natural methods of deposition (Waters 1992: 93). Specifically, archaeologically, the impetus to find aberrant deposits is to define man altered surfaces.

One of the best known factors for site burial is the alluvial fan. Alluvial fans form when high energy streams with sediment loads broaden into large valleys. The broadening of the valley disperses the energy of the flow of water, and under mechanisms discussed below, a loss of energy causes a precipitation of waterborne sediments. These alluvial deposits spread into large cones (Waters 1992:155). The cones are the product of the deposited sediments dropping from suspension, with the coarsest materials nearest the upland to valley transition with a gradual fining of materials to the downstream end of the fan formation. The movement of stream channels within alluvial fans is even more dynamic than other stream channels (Waters 1992:156). A prime example of an alluvial fan formation with extensive buried deposits exists within the research universe of the Tipton Till Plain of Indiana. The All Seasons site (12MI225) is located on an alluvial fan where a small stream exits the upland and enters the expanse of the Wabash River Valley (Cochran 1986). Due to the high probability for alluvial fans to contain buried archaeological deposits, it seems that when low energy sediments are present, testing should always be undertaken. Because of the stark differences between alluvial fan formation and the valley floor, as well as the comparative ease with which alluvial fan formations can be recognized, no analysis of alluvial fan formations within the research universe is undertaken in the current study.

The Section 106 process is focused on the discovery of sites, and particularly on the evaluation of the potential research significance of sites. With the research potential of buried deposits it is critical to understand the methods of site burial so that areas may be evaluated for the likelihood of containing buried deposits. Just as it is important to understand where sites are likely to exist on the surface, it is equally important to understand where sites are likely to exist in the subsurface. The key factor to understanding site burial is in understanding soils. The formation of soils within the valley is what allows sites to become buried. Therefore, to understand site burial and predict how it can occur, an understanding of the soils within the Tipton Till Plain is required.

Soils

Indiana has been subdivided into sixteen general soil regions (Ulrich 1966). These are illustrated in Figure 2. The Tipton Till Plain includes seven of these general soil regions (C, E, F, G, H, O, P). Region C consists of till plain soils formed under prairie vegetation. Prairie soils are high in natural fertility and organic content (Ulrich 1966: 87). Region E consists of till plain soils characterized by Miami-Crosby soils series. It is typified by nearly level till plain with silt and clay loam textured soils (Ulrich 1966: 88). Region F consists of nearly level till plain soils dominated by depressional soils with high clay contents. These soils form alongside Region E soils (Ulrich 1966: 89). Region G soils are similar to Region E soils except that they are located at the southern Wisconsin Glacial border. This area is characterized by silt and clay loam rich soils, but is deeply dissected by glacial outwash (Ulrich 1966: 89). Region H consists of alluvial derived soils. These soils are characterized by sorted materials derived from fluvial action, including glacial melt and modern river loads (Ulrich 1966: 68-70). Region O consists of sand dune soils. These soils comprise only a small portion of the Tipton Till Plain and are mainly limited to the eastern edge of the Lower Wabash River valley (Ulrich 1966: 73). Region P consists of aeolian loess soils. These soils are dominated by deep silts and are also found in only a small portion of the Tipton Till Plain, limited to the uplands at the eastern edge of the Lower Wabash River valley (Ulrich 1966: 74).

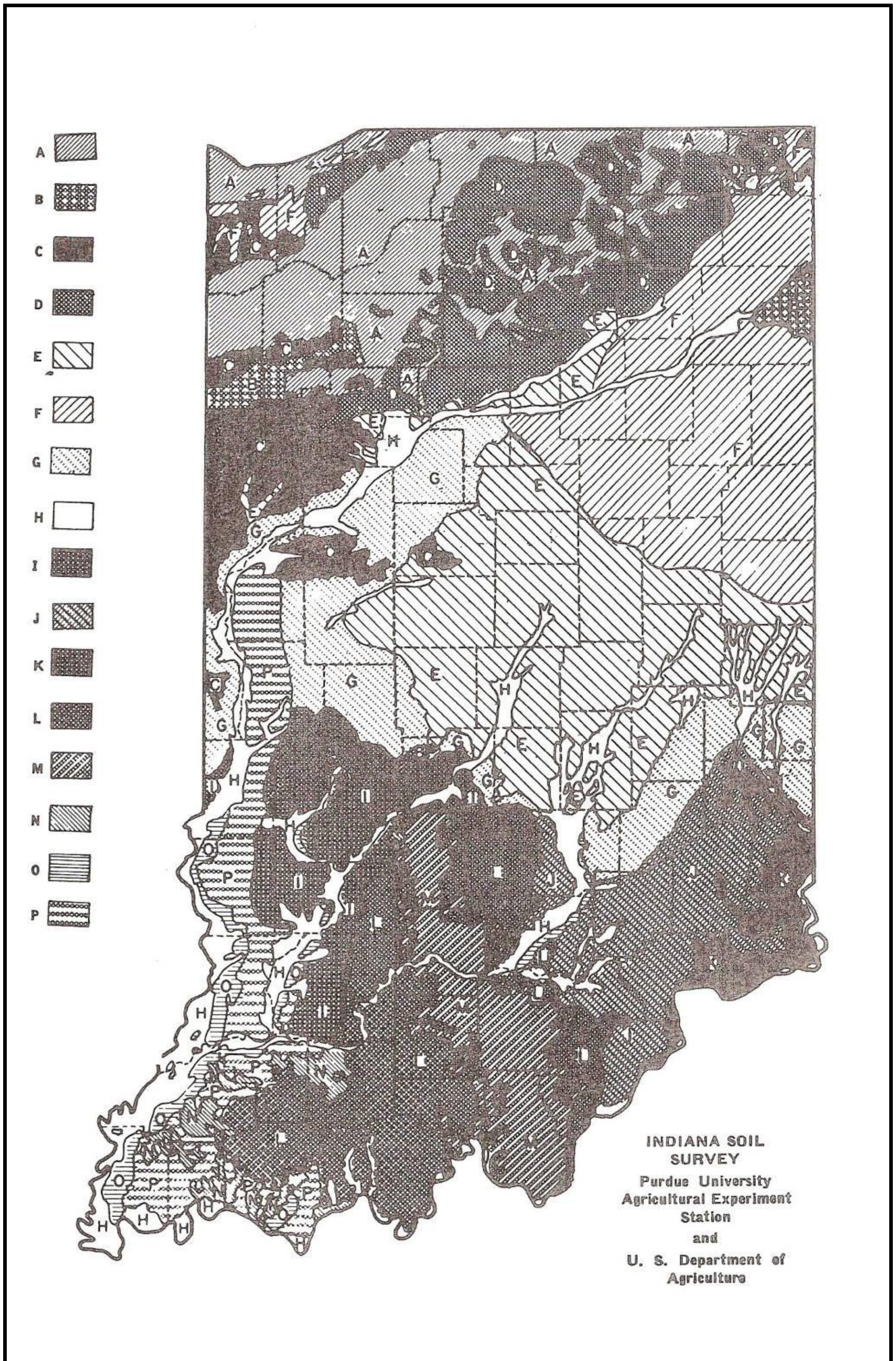

Figure 2. Soils of Indiana, from Ulrich 1966 adapted from NRCS Soil Surveys.

Alluvial soils are the most important soils for understanding the process of site burial in the Tipton Till Plain. This does not discount the importance of the origin of sediments from the till plain and terrace soils outside of the river bottom. The structure and nature of the sediments feeding the fluvial system are important to understand the origins of alluvial soils, but are not critical to the current study.

The dominant soil orders that are found within the floodplains of the Tipton Till Plain are Alfisols, Mollisols, Entisols and Inceptisols. Alfisols are soils that have developed to the point of visible soil horizons. They may have their origin in multiple parent materials (Natural Resources Conservation Service [NRCS] 1999: 163). Within the current research universe most of the Alfisols are derived from glacial outwash. These soils make up many of the outwash terraces found within modern stream and river valleys. They typically form under forest vegetation. Mollisols are characterized by a rich organic A horizon. Mollisols may have their origin in multiple parent materials (NRCS 1999: 555). Within the current research universe most Mollisols are derived from alluvial parent material. These soils are found in stream bottoms and in a few instances in the western part of the research universe in the uplands. Mollisols develop under prairie vegetation. Entisols are soils that are too young to have well developed soil horizons. They can have their origin in many parent materials, but are typically alluvial or colluvial soils (NRCS 1999: 389-392). Entisols do not have a typical vegetation because they can occur in so many environments. However, within the current research universe, Entisols typically form under hardwood vegetation, being generally lower topographically than Mollisols. Inceptisols are soils that show slight development of soil horizons (NRCS 1999: 489). They are similar to Entisols and for the current work will be treated very similarly. Inceptisols, just as Entisols, do not have a typical vegetation because of their wide distribution. However, within the current research universe, Inceptisols typically form under hardwood vegetation.

The manner in which sedimentation occurs is relatively simple. An increase in the rate at which water is moving increases both the amount and size of particle that can be held in suspension. Likewise, when the rate is decreased, the amount and size of particles that can be held in suspension decreases. When moving water losses energy and becomes oversaturated with sediment, deposition occurs. The type of deposition is dependent on the position of the landform affected and the energy level of the depositing water. Deposition of particles is also dependent on particle size. Gravels and sands, which require the greatest amount of energy, are the first to precipitate out of suspension. Deposits of this type are often referred to as high energy deposits because of the higher energy level required to initially hold these sized particles in suspension. High energy sedimentation is not considered to be conducive to the intact burial of archaeological deposits. As water loses energy, the portions of the fine earth fraction remaining in suspension become limited to silt and clay particles. Silt will precipitate out of suspension at higher energies more readily than clay, because of its lower buoyancy. Silt deposition is indicative of low energy water forces, and alluvial silt deposits are thought to have the highest potential for intact archaeological remains. Clay is deposited at the lowest energy level. Clay does not precipitate readily without very calm waters. Because of this, most areas containing predominately alluvial clays are slackwater and slough deposits where standing water is common (Waters 1992: 39-42). Slackwater and slough deposits are thought to be important resource procurement areas, but these poorly drained soils are not typically associated with State or National Register eligible sites (McCord et al. 2007).

Alluvial environments behave differently with regard to the type and amount of sediment available for transport. In particular, the origin of loess, a silt of aeolian derivation, is tied firmly to glacio-alluvial processes (Beavers and Albrecht 1948: 468-469). It appears that the silt that loess is predominantly composed of is a product of the chemical and mechanical weathering of glacial and riverine environments. Dried silts, exposed most frequently in outwash and alluvial settings, are the most susceptible to wind erosion (Beavers and Albrecht 1948). It would appear then that areas with the highest available loads of silts for alluvial transport would be in glaciated regions. While clay is a high percentage of the sediment within the till, silt also makes up a large part of the fine earth fraction in till plain soils. The silt within the Tipton Till Plain region is mostly derived from windblown particles from terrace formations associated with Mississippi River terraces (Hunt 1967: 125).

The behavior of soils in the presence of wind and water erosion is a function of the relative resistance to erosion of the soil (Waters 1992: 60). All things being equal, the larger the particle size, the more resistance to erosion because the necessary lift required for sediment movement is greater. However, while clays are a finer earth fraction than silts, the clastic, or aggregated nature of clays contributes to a lower erosion potential. Therefore, the most commonly transported fine earth fraction by means of wind and water is the silt fraction.

According to the process by which sediments are transported there is a significant difference in the ability of a water body to induce suspension of particulate based upon the composition of the soil. A formula for recognizing the potential and actual suspension carrying capacity of a water body has been constructed:

> The suspended matter content $C_s(g.m^{-3})$ is usually related to the water discharge Q $(m^3.s^{-1})$ as: $C_s = a'Q^{b'}$ with b'> 1 where a' varies according to the general turbidity of the river (Müller and Förstner, 1968). The total dissolved content (i.e. the sum of major ions and silica) Cd $(g.m^{-3})$ is usually linked to Q as: $Cd = a\ Q^b$ with generally $-1<b<0$ where a express the usual salinity of the river [Meybeck 1977: 28].

Such a formula as applied to river systems within Indiana is beyond the scope of the current project. A consilience of archaeology and geomorphology is requisite for the understanding of fluvial systems and predictive modeling. However, the actual implementation of such a formula to the potential for buried sites would require a familiarity with geology and mathematics beyond the standard training of most professional archaeologists.

With the additional limitations of the interpretation of Section 106 law, the actual implementation of such a regime in assessing buried site potential raises the amount of time and money required to make determinations. Any formula derived for the prediction of buried site potential requires an ease of use so that it can and will be used by qualified professionals. While a somewhat simplified method of determining buried site potential may lead to problems; the probable use of such a system as opposed to utilizing the more cumbersome formula above should make up for such problems.

Perhaps the most useful analysis tools for the archaeologist with regard to subsurface site potential are the United State Geological Survey county soil maps. While much can be said about the limitations of the soil surveys with regard to overgeneralization, they remain more important than any tool at the disposal of the archaeologist to determine the origin and nature of soils within an area. The soil surveys provide information concerning textural characteristics of soils, land slope, parent material and past vegetation. This can aid the archaeologist in determining first whether there is a potential for buried cultural deposits to exist in context within a given location. Additionally, the soil surveys document the drainage classes of soils within an area. These soils may exhibit highly varied textural classes and parent materials. It is hypothesized that knowledge of soils within a given drainage basin may also aid the archaeologist in determining the potential of a given site to undergo sedimentation.

Generally, glacial till consists of higher clay concentrations in the upper level of the pedologic unit than is typical in older soils. This is a product of the age and depositional characteristic of till. The soils within till, as opposed to outwash soils are not well sorted. This means that particle size within the upper horizon of till soils vary from boulders to fine clays. During the Holocene these soils have had time to develop, but not to the point that eluviation has occurred to a significant extent. This high clay content leads to a slow permeability and increased runoff. The permeability of soils will determine the amount of surface water available to erode soil particles in a given area. Areas with lower permeability rates will have higher runoff totals during rain events than areas that are rapidly permeable. This increased surface flow can add to flood episodes and therefore scouring and depositional episodes. It may be that greater clay content leads to lower impermeability, higher runoff, higher sediment loads and higher downstream sedimentation (Leopold et al. 1992: 38).

Multiple soil series have been sampled during subsurface investigations. The ones covered in the current research have been listed and characterized based upon general series descriptions (Table 1). Information has been included that shows the depth of the A-horizon, alluvial depth and a typical profile. In soil profiles, the A-horizon is characterized as an organic horizon. Most A-horizon soils within Indiana are actually Ap-horizons, where the p indicates a plowzone. B-horizons are areas of elluviation, or the accumulation of leached clays. B-horizons are mineral horizons, with little organic matter. B-horizons may be characterized by multiple subhorizons. In the current research two subhorizons are indicated in the general soil profiles. These are w and g, where w indicates weak soil development due to the young age of the soil and where g indicates gleyed soils indicative of a high and fluctuating water table in poorly drained soils. C-horizon soils are undeveloped parent material. The C-horizons are either too deep to have undergone elluviation/illuviation—or too young to have developed. Elluviation is the process of clay particles precipitating from a horizon (Soil Science Society of America 2010). Illuviation is the process of clay particles accumulating in a horizon (Soil Science Society of America 2010). Elluviation and Illuviation are aspects of the same process and result in some of the textural differences between soil horizons. Elluviation/illuviation is a process and the amount of elluviation/illuviation can denote very generally the amount of time a given horizon was at or near the surface. BC-horizons are soil horizons that share characteristics of B and C horizons. These are more typical within older soils. Bw and C-horizons can indicate accretional alluvial, colluvial or aeolian soils.

Table 1. Typical Profiles of Tested Soils within the Research Universe. (NRCS 2009)

Series	**Order**	**Drainage**	**Typical Profile**	**A depth**	**Alluvium Depth**
Battleground	Mollisol	Well	A, Bw	48 cm	> 200 cm
Chagrin	Inceptisol	Well	A, Bw, C	22 cm	80 cm
DuPage	Mollisol	Well	A, C	80 cm	> 150 cm
Eel	Entisol	Moderately Well	A, Bw, BC, C	25 cm	80 cm
Fox	Alfisol	Well	A, B, C	22 cm	NA
Genesee	Entisol	Well	A, Bw, C	20 cm	80 cm
Landes	Mollisol	Well	A, Bw, BC, C	32 cm	75 cm
Piankeshaw	Inceptisol	Well	A, Bw, C	15 cm	> 120 cm
Ross	Mollisol	Well	A, A2, Bw, C	75 cm	> 200 cm
Rush	Alfisol	Well	A, B, BC, C	25 cm	NA
Shoals	Entisol	Somewhat Poor	A, Bw, C	20 cm	100 cm
Sloan	Mollisol	Very Poor	A, Bg, C	38 cm	86 cm
Tice	Mollisol	Somewhat Poor	A, Bw, C	32 cm	80 cm

Chapter 3. Methods

Literature Review

The methods used for the research on whether the current factors for recommending subsurface investigations in the Tipton Till Plain region are justified have been to collect data from compliance reports where Phase Ic subsurface reconnaissance was employed as a method of site discovery in the Tipton Till Plain region. The records reviewed are not exhaustive of the Tipton Till Plain portions of Indiana. The materials reviewed were on file at the Archaeological Resources Management Service (ARMS) at Ball State University, and were limited to reconnaissance conducted by the ARMS. Only the reports on file at the ARMS were reviewed because files at the Indiana Division of Historic Preservation and Archaeology were not categorized by phases and a complete search was not possible. In addition, the Indiana Division of Historic Preservation and Archaeology does not maintain reliable data on projects conducted prior to the 1990's.

Data Analysis

With the known mechanism by which solids are transported and deposited in alluvial settings, it is possible to approximate from specific known examples in glaciated portions of Indiana to a larger framework of possible buried site potential. The current study uses 26 examples of subsurface reconnaissance within the Tipton Till Plain portion of Indiana (Appendix A). The subsurface investigations were carried out between 1988 and 2005 by ARMS, and utilized mechanically excavated trenches. The methods utilized in all instances involved slowly scraping off the plowzone. When no features were encountered at the base of the plowzone, excavation continued to Pleistocene deposits, high energy deposits or the water table. The trench walls were scraped in order to locate artifacts or features and then were profiled to analyze the soil deposition. Most of the subsurface studies were recommended based upon the presence of well drained, low energy alluvial deposits. The data were analyzed for the existence of artifacts, the proximity to the depositional water source, stream order and soil taxonomic classification.

Projects that discovered subsurface sites were analyzed in greater detail. As a function of the known mechanism by which low energy deposition occurs, the relation between the permeability of the soils within the immediate drainage basin were compared to the permeability of soils upstream from the location. This analysis was conducted because it was hypothesized that areas of permeable soils downstream from less permeable soils would absorb water, reducing the total amount of sediment the water is able to transport, and sediment precipitation would occur.

Also, measurements of the valley width at the point where the subsurface investigation occurred were taken as well as measurements of the valley width every 0.4 km to a distance of 3.2 km upstream from the subsurface investigation area. The measurements were all then divided by the first measurement (the width at the subsurface investigation area) to provide a ratio based on the width at the subsurface investigation area. This allowed the measurements to be compared to measurements from other valleys. These measurements were undertaken to test whether river valleys operate in a manner similar to alluvial fans. That is, alluvial fans are caused by the constricted flow of water with suspended sediments abruptly undergoing a reduction of energy by dramatic valley width widening, and therefore a precipitation of sediments. The measurements and analysis of the width of river systems and the determination of whether the same processes occur in less dramatic valley widening may aid in predicting the locations of buried deposits. Additional analyses of soil taxonomy and drainage characteristics gathered from the NRCS are analyzed along with the effects stream order and proximity to water have on the potential for an area to contain buried deposits.

GIS Methodology

In order to analyze the information, a GIS database was created to manipulate the soils information utilizing ArcGIS 9.2 and Database IV software. Soil data by county (NRCS 2009) was input into the ArcGIS workspace and clipped utilizing a georeferenced polygon representing the Tipton Till Plain (Gray 2000, Figure 3). A geodatabase was then created in ArcCatalog and a topology was created by importing all clipped county soil feature classes. This data was added to the ArcGIS workspace. Data on the permeability of the soils within the soil features was extracted from the comp.txt file located within the tabular data associated with the county soils. This data was processed into readable Database IV files with the permeability classes associated with individual soil MU_KEY data. In the ArcGIS workspace each county file was joined with the table containing permeability classes. The soils internal feature polygons were then dissolved according to the permeability of the soils. This created new polygons with boundaries based not upon individual soils, but based upon the permeability of the given soils. This created a general map of till plain permeability (Figure 4). The classification of soils into permeability is along a continuum. Category A soils have a rapid infiltration and are the most permeable soils, Category D has a slow permeability and a high runoff (Smallwood and Osterholz 1990: 93). The categories are assigned impermeability rates that are listed in Table 2. Category E soils are significantly man altered and had to be assigned an average impermeable rate. It was necessary to include an average for E category soils in order to run the GIS model. However, in all areas the amount of E category soils was insignificant in relation to the analysis of the investigation areas.

Table 2. Soil Impermeability by Category.

Category	Impermeable Rate	Category	Impermeable Rate
A	0.3	D	0.77
B	0.55	E	0.6
C	0.7		

Individual subsurface areas were reviewed to determine the extent of the upstream drainage flowing to the areas tested. The upstream drainages were then selected and exported into a spreadsheet with the individual area and permeability of the drainage basins. The information was then put into a spreadsheet for analysis.

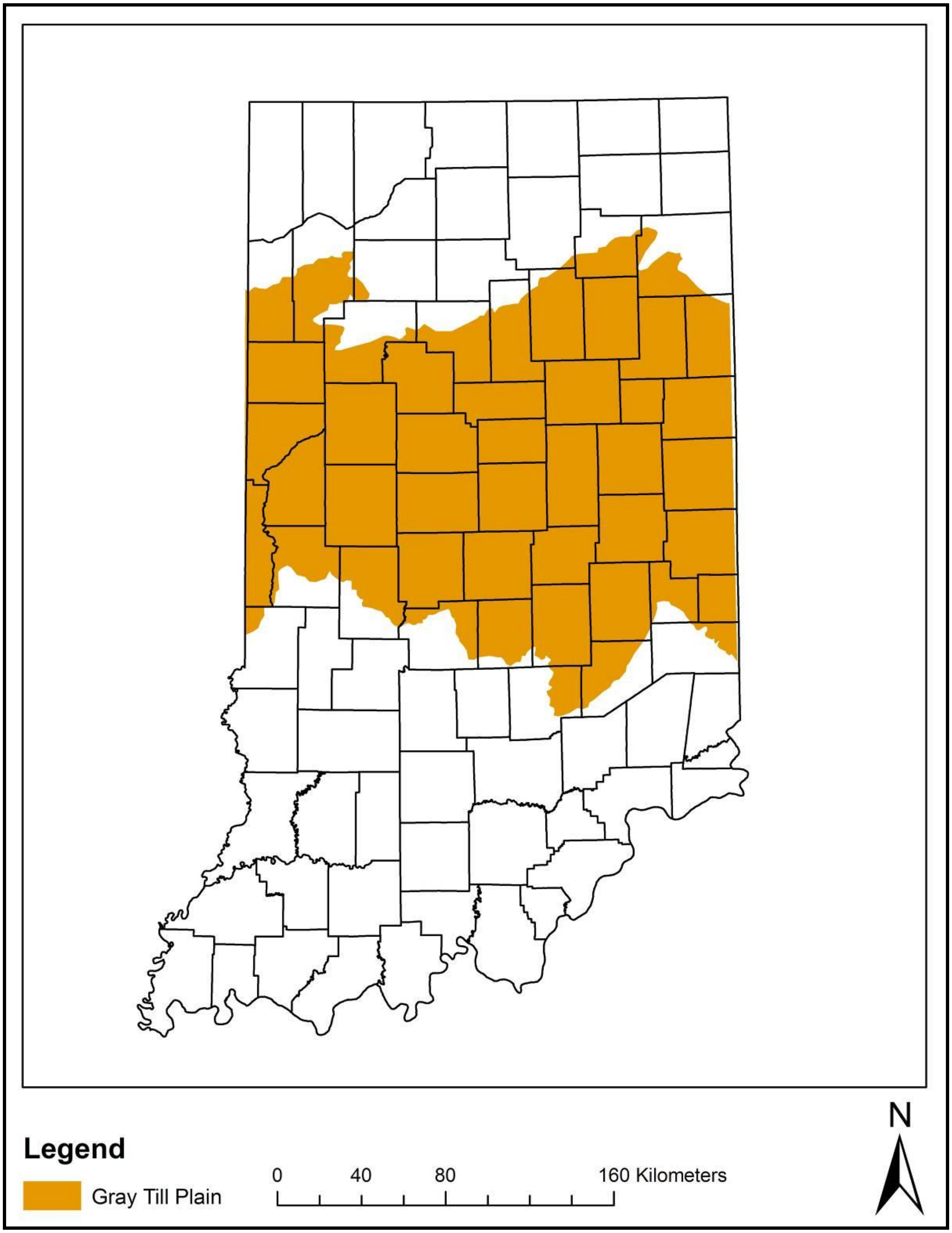

Figure 3. The Tipton Till Plain in Indiana as defined by Gray (2000).

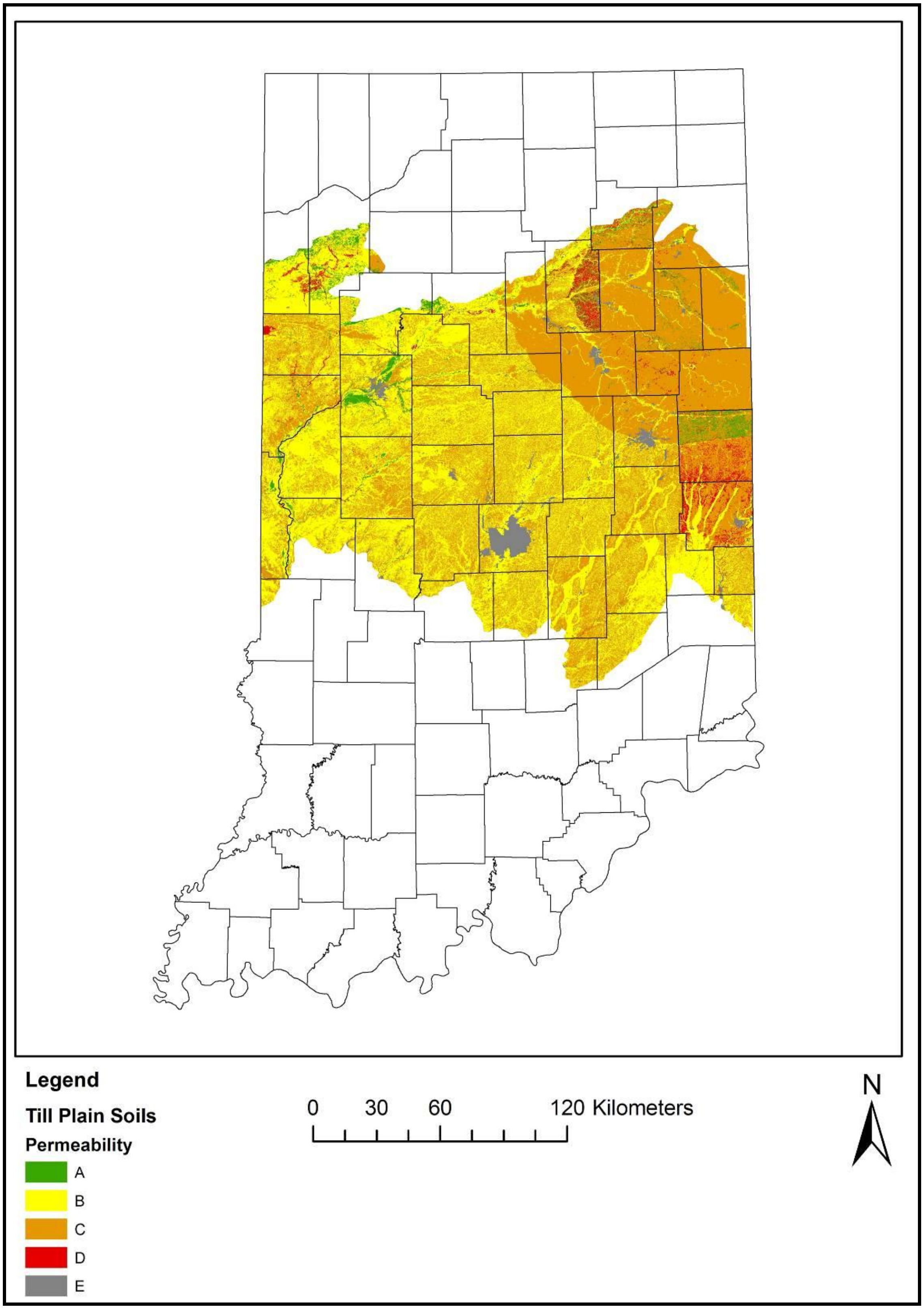

Figure 4. Permeability map of the Tipton Till Plain in Indiana created in ArcGIS.

The display of all counties within the research universe created an almost seamless connection along borders when comparing the permeability categories. Jasper and Wells, however, appeared significantly different than surrounding counties and upon closer inspection, soils endemic to many counties categorized as one class of permeability were classified differently in Jasper and Wells counties. A change was made in the categorization of specific soils when correlate or same soils were consistently categorized differently than the abhorrent counties. The metadata file of the soil data created in GIS is included as Appendix B.

Chapter 4. Investigation Areas

Analysis and descriptions of individual investigation areas were undertaken and the information deemed relevant for the understanding of the potential for site burial was included. Each investigation area was assigned a number for simplified analysis. The detailed analyses are included as Appendix A. This information includes soils within project areas, valley width and a description of the valley as it pertains to potential site burial. This data, in conjunction with the results of the subsurface investigation, may provide information key to determining the potential for locations to contain intact buried deposits. For the purposes of this undertaking the valley was defined as the valley floor—the area of low relief immediately surrounding the stream to the edge of where county soil maps define soils of alluvial and outwash origin. The location of the investigation areas within the Tipton Till Plain region is shown in Figure 5 and a general background of the areas is included in Table 3.

Table 3. General Information on Investigation Areas.

Investigation Area	County	Nearest Flowing Water	Drainage Basin
1	Huntington	Silver Creek	Wabash
2	Huntington	Silver Creek	Wabash
3	Cass	Wabash	Wabash
4	Carroll	Wabash	Wabash
5	Grant	Lugar Creek	Mississinewa
6	Tippecanoe	Wabash	Wabash
7	Tippecanoe	Wabash	Wabash
8	Warren	Big Pine Creek	Wabash
9	Montgomery	Sugar Creek	Wabash
10	Putnam	Raccoon Creek	Eel

Table 3. General Information on Investigation Areas.			
Investigation Area	**County**	**Nearest Flowing Water**	**Drainage Basin**
11	Putnam	Walnut Creek	Eel
12	Wayne	Whitewater	Whitewater
13	Henry	Blue River	Driftwood
14	Madison	Fall Creek	Upper White
15	Madison	White River	Upper White
16	Hamilton	White River	Upper White
17	Hamilton	White River	Upper White
18	Hamilton	White River	Upper White
19	Hamilton	White River	Upper White
20	Marion	Fall Creek	Upper White
21	Rush	Arlington Run	Driftwood
22	Rush	Little Conns Creek	Driftwood
23	Decatur	Flatrock River	Flatrock
24	Fayette	Williams Creek	Whitewater
25	Fayette	Fall Creek	Whitewater
26	Franklin	Dry Fork	Whitewater

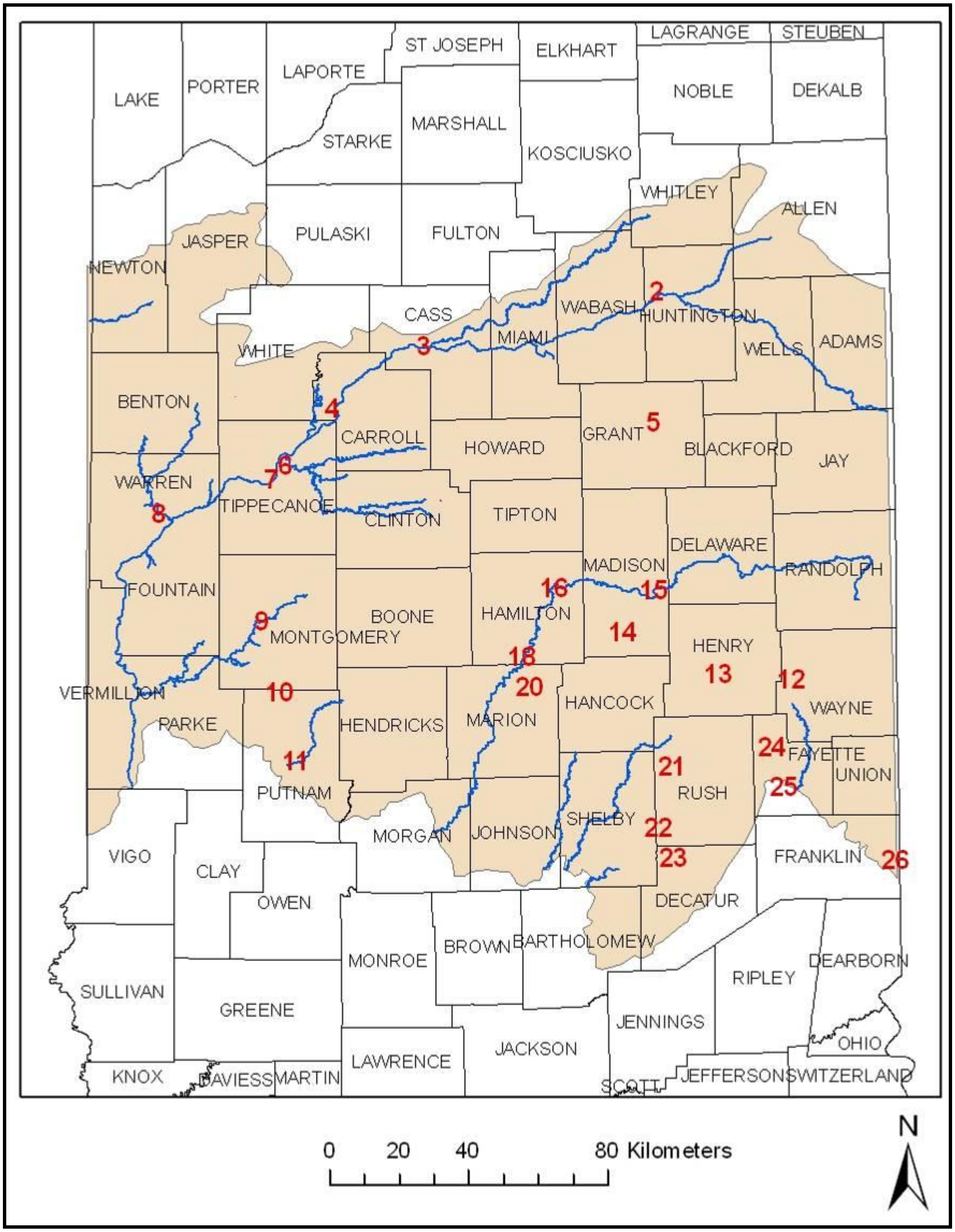

Figure 5. Location of Subsurface Investigations within the Tipton Till Plain. (note: due to the scale some areas were not labeled. Area 1 is near area 2, areas 17 and 19 are near area 18) Refer to Appendix A for description of Investigation Areas.

Chapter 5. Results

After computing soils data in GIS to reflect the percent of impermeability by drainage basin, a map was generated (Figure 6). A complete list of the individual metadata associated with this GIS layer file is included in Appendix B.

The data generated by analyzing the subsurface area permeability in relation to upstream permeability revealed that no relation exists at the scale available between permeability and subsurface site potential. Individual areas known to contain subsurface deposits appeared very similar to areas predicted to have no potential for subsurface deposits. The areas were analyzed for the acreage upstream from the investigation area. A total impermeable area and percentage of the upstream portions of the drainage basin was generated from the attributes created in ArcGIS (see Appendix B). The upstream impermeability was divided by the individual drainage basin impermeability to create a ratio. This was then compared to the impermeability of the soils within the individual drainage basin where the investigation occurred (Table 4). The range of ratios was small, and the buried sites occur at both the high and low ends. It appears that this method for locating buried sites is likely to produce incorrect predictions. Eight of the 26 areas could not be tested in this manner because they were first order streams, and so were not connected with upstream drainage basins.

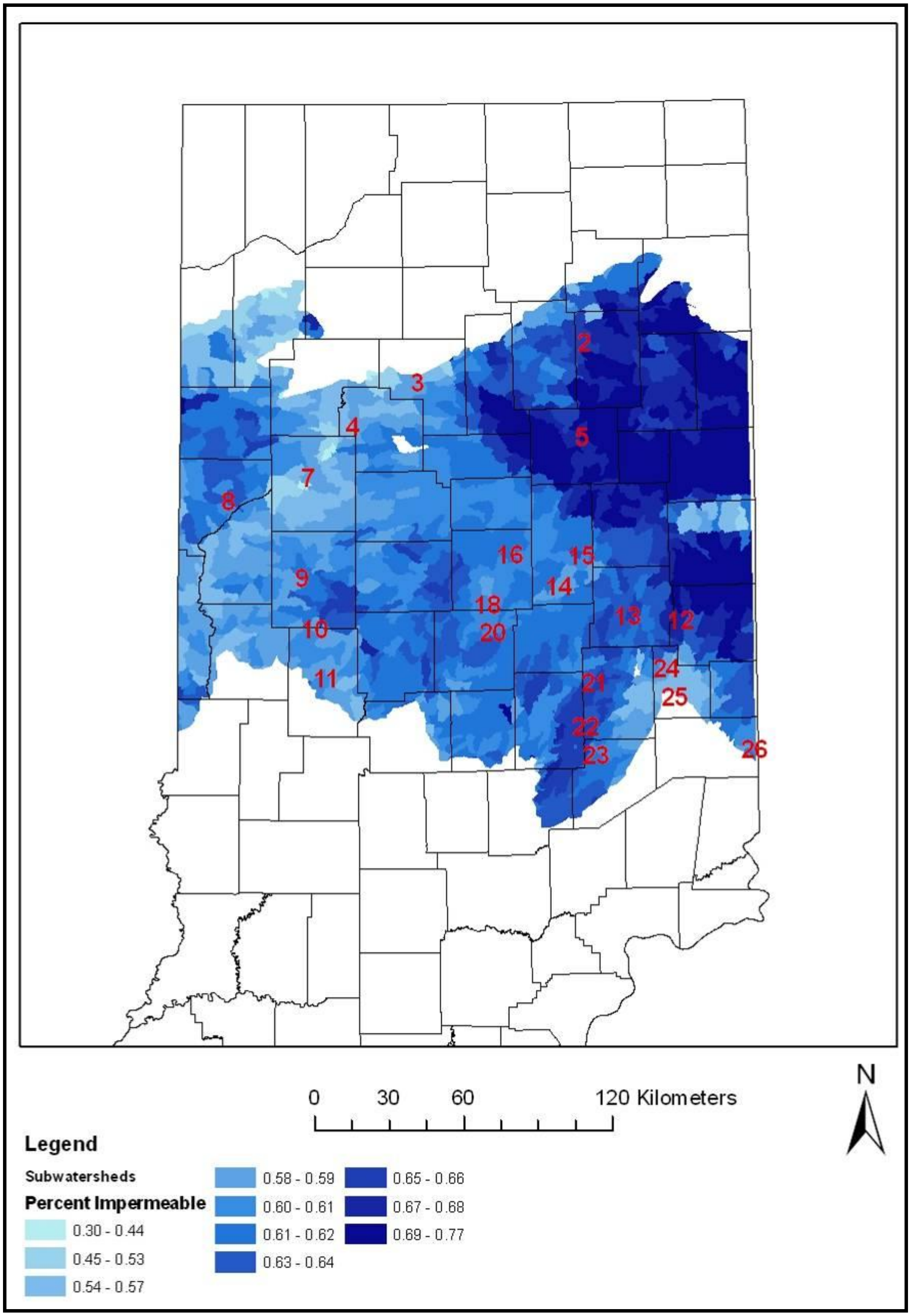

Figure 6. Drainage basins represented by their percentage of impermeability with the locations of subsurface investigations within the Tipton Till Plain (note: due to the scale some areas were not labeled. Area 1 is near area 2, areas 18 and 20 are near area 19).

Table 4. Investigation Area Permeability in Relation to Upstream Permeability							
Investigation Area	**Total Upstream Acreage**	**Total Impermeable**	**Impermeable Percent**	**Individual Basin Percent Impermeable**	**Upstream Area Impermeability Divided by Drainage Basin Impermeability**	**Individual Soil Impermeability**	**Assessment**
3	610334.1	384913.1	0.63066	0.58000	1.087344253	0.55	Deposits
6	452414.2	263974.4	0.58348	0.58386	0.99934826	0.55	No Potential
7	452414.2	263974.4	0.58348	0.58386	0.99934826	0.55	Intact Deposits
9	324493.0	197107.0	0.60743	0.61537	0.98709828	0.55	Intact Deposits
10	63247.5	39563.2	0.62553	0.57880	1.080735769	0.55	No Potential
11	146728.8	88823.3	0.60536	0.59831	1.011778105	0.55	No Potential
13	41850.0	28764.7	0.68733	0.67870	1.012713355	0.55	No Potential
14	38354.0	24206.8	0.63114	0.64052	0.985357946	0.7	No Potential
16	260270.9	170648.1	0.65566	0.60378	1.085918221	0.55	Intact Deposits
17	405617.3	257083.3	0.63381	0.61085	1.037582929	0.55	Intact Deposits
18	493906.3	305995.0	0.61954	0.60441	1.025033651	0.55	No Potential
19	493906.3	305995.0	0.61954	0.60441	1.025033651	0.55	Moderate
20	493906.3	305995.0	0.61954	0.60441	1.025033651	0.55	No Potential
21	75417.7	47732.8	0.63291	0.58632	1.079465877	0.55	No Potential
23	31793.6	20065.7	0.63112	0.63571	0.992785821	0.7	No Potential
24	176681.8	105972.7	0.59979	0.61572	0.974134498	0.55	No Potential

Another method utilized was to measure the change in valley width upstream from the investigation area. It was hypothesized that a constricted flow of water with suspended sediments undergoing a reduction of energy by valley widening would cause an increased precipitation of sediments. Measurements of the valley width at the point of the subsurface investigation were taken as well as every 0.4 km upstream from the investigation area to a distance of 3.2 km. The raw data is presented in Table 5. Additionally, an analysis of the upstream valley width as a ratio of the width of the valley at the site of the subsurface investigation was conducted (Table 6).

Table 5. Measurements of the Valley Width at the Subsurface Investigation Area and Upstream.

Investigation Area	at 0 km (in meters)	at 0.4 km (in meters)	at 0.8 km (in meters)	at 1.2 km (in meters)	at 1.6 km (in meters)	at 2.0 km (in meters)	at 2.4 km (in meters)	at 2.8 km (in meters)	at 3.2 km (in meters)
1	400	370	290	290	480	280	310	250	320
2	370	290	290	480	280	310	250	320	180
3	2060	2330	2610	2910	2650	2750	2800	3040	3110
4	2600	2870	2920	2900	2960	2880	2350	1470	1250
5	290	230	310	280	350	390	280	280	240
6	1380	1690	1770	1850	2130	2150	2230	2300	2250
7	1050	1180	1130	1100	1160	940	800	720	760
8	380	600	740	1420	1540	1050	490	660	580
9	700	1150	540	600	900	360	640	380	460
10	590	720	1050	620	950	1280	790	570	560
11	750	1050	1140	1230	820	1070	1120	980	660
12	1400	1230	980	860	850	860	1000	1120	1100
13	800	1250	1320	1150	1120	1080	1160	1250	1370
14	840	910	720	560	590	540	500	610	440
15	610	600	600	560	530	370	510	450	370
16	2230	2250	2330	2190	1170	1390	880	820	840
17	2290	2480	2200	2450	2660	2750	2790	2430	2350
18	2200	2240	1760	2220	2290	2480	2200	2450	2660
19	2200	2240	1760	2220	2290	2480	2200	2450	2660
20	450	430	320	390	470	520	470	510	490
21	430	610	250	270	330	190	170	210	230
22	180	190	120	130	100	70	0	0	0
23	650	320	250	700	660	400	530	530	730
24	230	210	190	180	160	160	290	250	200
25	250	260	330	210	280	190	130	110	90
26	120	190	170	190	220	110	90	140	140

Table 6. Measurements as a Ratio of the Width at the Investigation Area.

Investigation Area	at 0 km (in meters)	at 0.4 km (in meters)	at 0.8 km (in meters)	at 1.2 km (in meters)	at 1.6 km (in meters)	at 2.0 km (in meters)	at 2.4 km (in meters)	at 2.8 km (in meters)	at 3.2 km (in meters)
1	1	1.1038	1.1231	1.1154	1.1385	1.1077	0.9038	0.5654	0.4808
2	1	1.4000	1.5200	1.6400	1.0933	1.4267	1.4933	1.3067	0.8800
3	1	1.0182	0.8000	1.0091	1.0409	1.1273	1.0000	1.1136	1.2091
4	1	1.0182	0.8000	1.0091	1.0409	1.1273	1.0000	1.1136	1.2091
5	1	0.7838	0.7838	1.2973	0.7568	0.8378	0.6757	0.8649	0.4865
6	1	1.4186	0.5814	0.6279	0.7674	0.4419	0.3953	0.4884	0.5349
7	1	0.4923	0.3846	1.0769	1.0154	0.6154	0.8154	0.8154	1.1231
8	1	1.2246	1.2826	1.3406	1.5435	1.5580	1.6159	1.6667	1.6304
9	1	1.0833	0.8571	0.6667	0.7024	0.6429	0.5952	0.7262	0.5238
10	1	0.7931	1.0690	0.9655	1.2069	1.3448	0.9655	0.9655	0.8276
11	1	1.0830	0.9607	1.0699	1.1616	1.2009	1.2183	1.0611	1.0262
12	1	1.2203	1.7797	1.0508	1.6102	2.1695	1.3390	0.9661	0.9492
13	1	1.0556	0.6667	0.7222	0.5556	0.3889	0.0000	0.0000	0.0000
14	1	1.5625	1.6500	1.4375	1.4000	1.3500	1.4500	1.5625	1.7125
15	1	1.1238	1.0762	1.0476	1.1048	0.8952	0.7619	0.6857	0.7238
16	1	0.9556	0.7111	0.8667	1.0444	1.1556	1.0444	1.1333	1.0889
17	1	1.5833	1.4167	1.5833	1.8333	0.9167	0.7500	1.1667	1.1667
18	1	1.5789	1.9474	3.7368	4.0526	2.7632	1.2895	1.7368	1.5263
19	1	0.4565	0.2609	0.1957	1.0652	0.8696	0.4348	0.2174	0.9130
20	1	0.8786	0.7000	0.6143	0.6071	0.6143	0.7143	0.8000	0.7857
21	1	1.0400	1.3200	0.8400	1.1200	0.7600	0.5200	0.4400	0.3600
22	1	1.6429	0.7714	0.8571	1.2857	0.5143	0.9143	0.5429	0.6571
23	1	0.4923	0.3846	1.0769	1.0154	0.6154	0.8154	0.8154	1.1231
24	1	0.9130	0.8261	0.7826	0.6957	0.6957	1.2609	1.0870	0.8696
25	1	1.0400	1.3200	0.8400	1.1200	0.7600	0.5200	0.4400	0.3600
26	1	1.5833	1.4167	1.5833	1.8333	0.9167	0.7500	1.1667	1.1667

This analysis revealed that there may be a connection between valley width ratios and buried site potential. Areas known to contain buried deposits demonstrated that the valley at the point of buried deposits as a ratio to the width of the valley upstream to a distance of 3.2 kilometers is fairly steady. Investigation areas 8, 15 and 18 did not contain buried deposits but were considered to have the potential for intact buried deposits. Investigation areas 1, 3, 5, 7, 9, and 16 did have buried deposits. A graph of the ratios of these investigation areas was created (Figure 7). This is then compared with graphs made to represent areas which were determined not to have the potential for intact deposits (Figures 8 and 9).

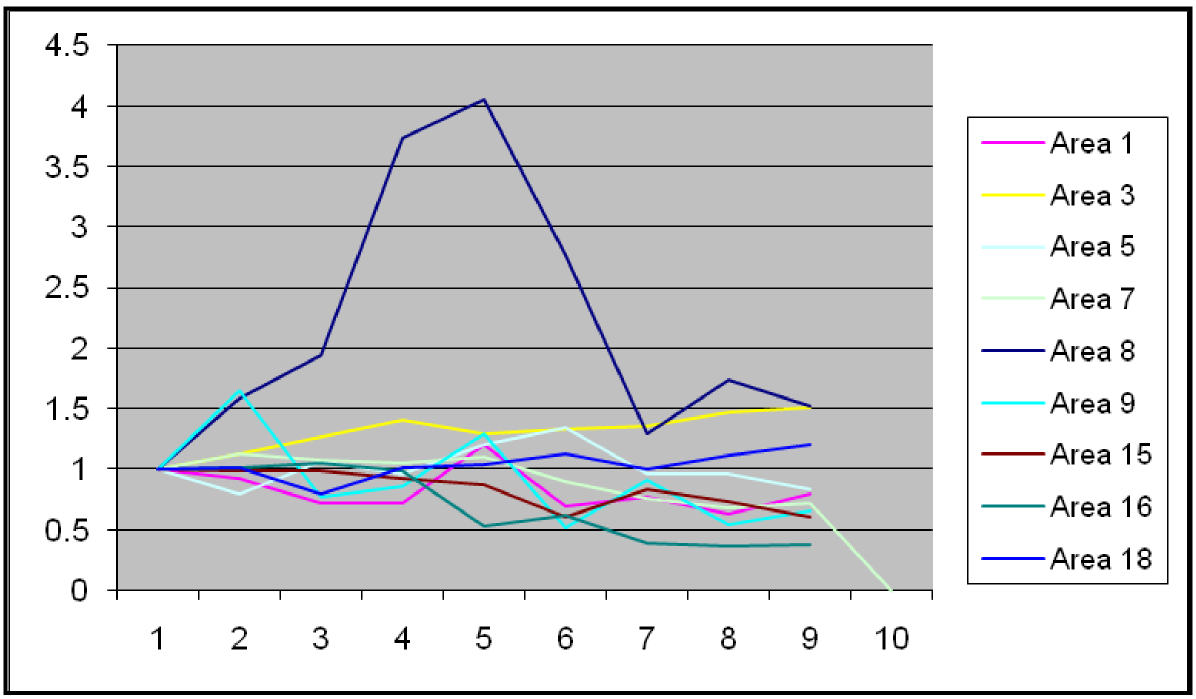

Figure 7. Subsurface areas found to have intact deposits or to have the potential for intact deposits. The y-axis represents the ratio based on the initial valley width. The x-axis is the measurements at 400 meter intervals.

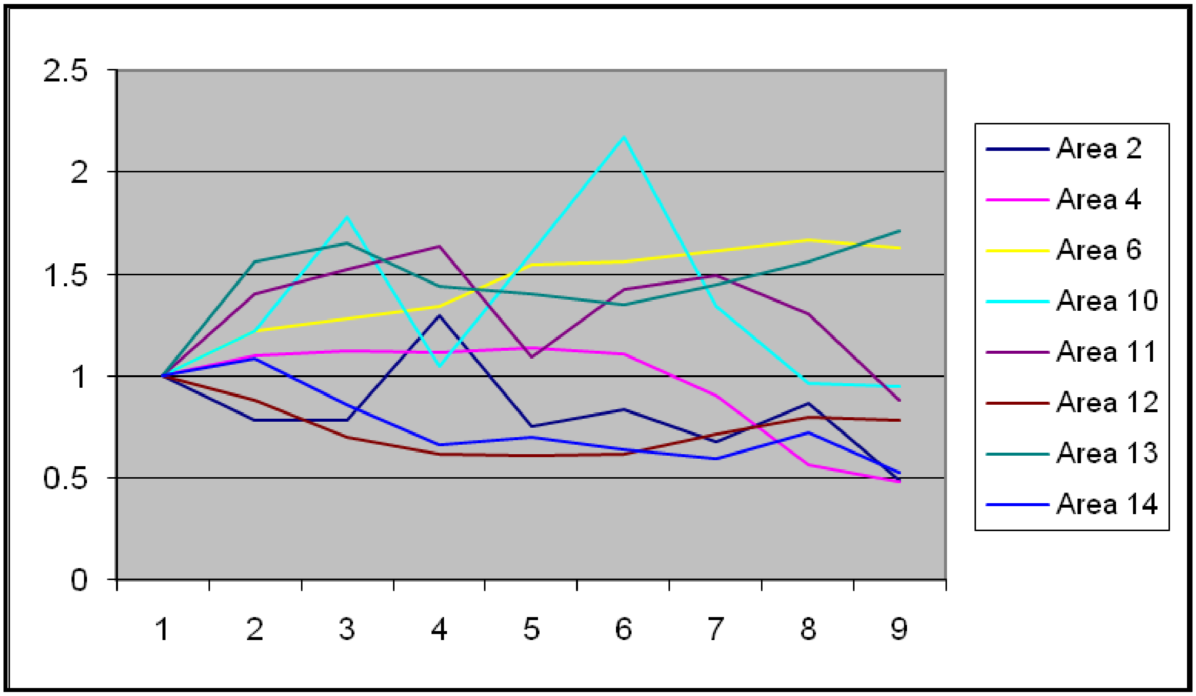

Figure 8. Subsurface areas found to have little to no potential for intact deposits. The y-axis represents the ratio based on the initial valley width. The x-axis is the measurements at 400 meter intervals.

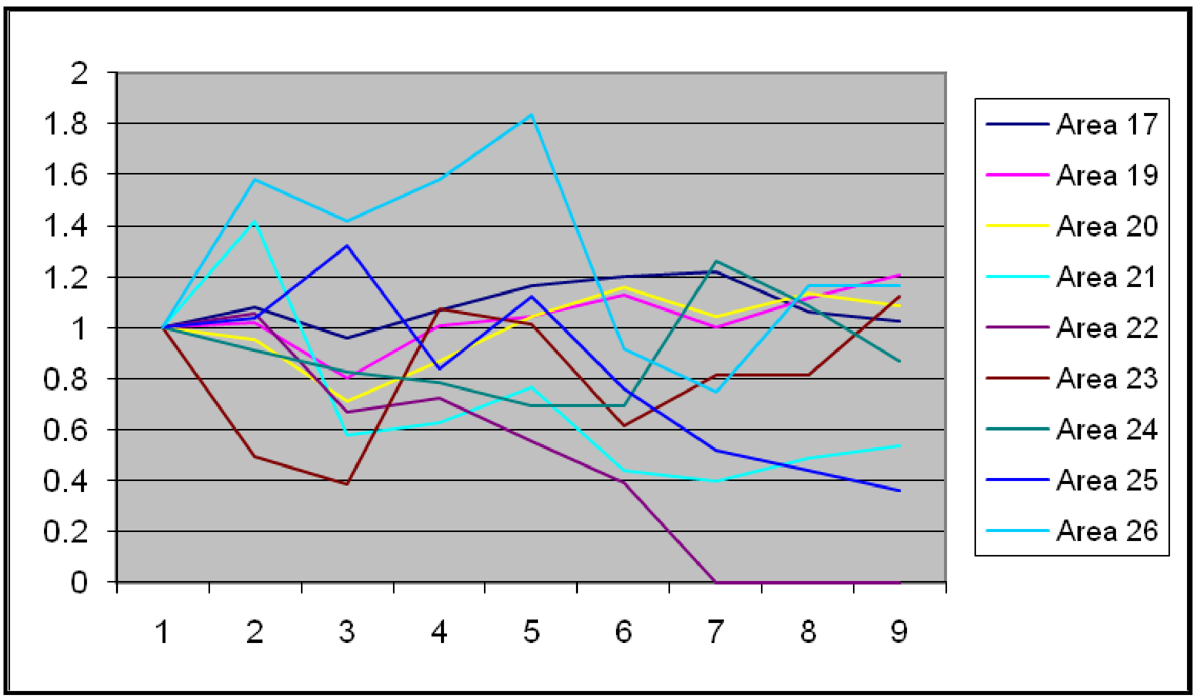

Figure 9. Subsurface areas found to have little to no potential for intact deposits. The y-axis represents the ratio based on the initial valley width. The x-axis is the measurements at 400 meter intervals.

The data appears to show that areas with a higher potential for intact deposits are located within valleys with a stable width upstream. It was hypothesized that areas with broad valleys downstream from constrictions in the valley would be the most likely to contain intact deposits. However, the areas with the greatest potential, with the exception of Investigation Area 8, showed only minor variations in the valley width at the point of investigation in relation to the valley upstream. A workable hypothesis for locating buried sites within the Tipton Till Plain in Indiana then is: When the valley width at a given location is stable in comparison with the valley width upstream to a distance of greater than 3 km, there is an increased probability of locating intact buried deposits.

It was thought that there might be a correlation between the type of soils and the potential for buried sites. A table, based on the NRCS soil classification system was created (Table 7). This table shows the taxonomic class, soil series as well as whether artifacts were recovered, and the depths where artifacts were recovered. With regard to the taxonomic classification, the suffix -olls refers to Mollisols, the suffix -epts refers to Inceptisols, and the suffix –alfs refers to Alfisols. Fluventic, Fluvaquentic, and Udifluvent refer to water processes in soil development, with Fluventic being the driest, Fluvaquentic being in the middle, and Udifluvent having an almost perennial high water table (NRCS 1999:179). Cumulic Hapludolls are categorized based on multiple factors, but perhaps the most important is that they cannot contain more than 50 percent sand in the upper 50 cm. Typic refers to soils that strictly meet the classification of the soil order (in the case below Alfisols and Inceptisols). A full description of the soil taxonomic classes is beyond the scope of this work. For full information on each given taxonomic class refer to the soil classification system (NRCS 1999).

Table 7. Soil Taxonomic Classes Investigated within the Research Universe.				
Taxonomic Class	**Soil Series**	**Artifacts**	**Depth**	**Investigation Area**
Cumulic Hapludolls	Du Page	no	NA	8
Cumulic Hapludolls	Ross	no	NA	8
Cumulic Hapludolls	Ross	yes	20-100	16
Fluvaquentic Endoaquolls	Cohoctah	no	NA	4
Fluvaquentic Endoaquolls	Sloan	no	NA	21
Fluvaquentic Eutrudepts	Eel	no	NA	24
Fluvaquentic Hapludolls	Tice	no	NA	6
Fluventic Endoaquepts	Shoals	no	NA	10
Fluventic Endoaquepts	Shoals	no	NA	13
Fluventic Endoaquepts	Shoals	no	NA	19
Fluventic Endoaquepts	Shoals	no	NA	22
Fluventic Eutrudepts	Chagrin	no	NA	10
Fluventic Eutrudepts	Chagrin	no	NA	11
Fluventic Eutrudepts	Chagrin	no	NA	23
Fluventic Eutrudepts	Genesee	yes	26-76	1
Fluventic Eutrudepts	Genesee	no	NA	2
Fluventic Eutrudepts	Genesee	no	NA	12
Fluventic Eutrudepts	Genesee	no	NA	14
Fluventic Eutrudepts	Genesee	yes	45	15
Fluventic Eutrudepts	Genesee	no	NA	17
Fluventic Eutrudepts	Genesee	no	NA	18
Fluventic Eutrudepts	Genesee	no	NA	20
Fluventic Eutrudepts	Genesee	no	NA	25
Fluventic Eutrudepts	Genesee	no	NA	26
Fluventic Eutrudepts	Genesee	yes	20-100	16
Fluventic Eutrudepts	Genesee	no	NA	21
Fluventic Eutrudepts	Piankeshaw	no	NA	4
Fluventic Hapludolls	Battleground	yes	80-170	7
Fluventic Hapludolls	Battleground	no	NA	6
Fluventic Hapludolls	Landes	yes	20-120	9
Fluventic Hapludolls	Landes	yes	55	5
Typic Hapludalfs	Fox	no	NA	23
Typic Hapludalfs	Rush	yes	20-80	3
Typic Udifluvents	Stonelick	no	NA	11

The taxonomic soil class appeared to have a significant impact on the potential for buried sites. It is known that, especially with regard to Woodland sites, there is a preference for long term settlement on Mollisols (Stephenson 1984: 120). Stephenson claimed that in the Upper White River: "Ross soils, the only dry prairie-like soils within the drainage, were located adjacent to, directly across the river from, or within one-half mile of these [pottery bearing] sites" (Stephenson 1984: 119). There appears to be a difference in positive correlations for the discovery of buried deposits on Mollisols compared to Inceptisols within the research universe. Some investigation areas contained both Mollisols and Inceptisols and when two soil types occurred within the same area the results were split between them. Table 7 demonstrates that on Mollisols forty percent of the time subsurface investigations encountered buried deposits. This compares to a fourteen percent rate of discovery of buried deposits on Inceptisols.

There is also a correlation between the water table and the potential for buried sites. Among the areas investigated, none with high to perennially high water tables (Fluvaquentic and Udifluvent) contained buried archaeological deposits. This may indicate the absence of buried deposits, or it may also be related to the inability to investigate areas with high water tables due to trench infiltration.

The depth of the water table is closely correlated to, but does not always correspond to, the drainage characteristics of a soil. To test the effect of drainage characteristic on the potential for the discovery of buried sites, a table detailing the drainage characteristics of soils investigated within the research universe was created (Table 8).

Table 8. Soil Drainage Classes Investigated within the Research Universe.

Drainage	**Soil Series**	**Artifacts**	**Depth (cm)**	**Investigation Area**
Very Poor	Sloan	no	NA	21
Poor to Very Poor	Cohoctah	no	NA	4
Somewhat Poor	Tice	no	NA	6
Somewhat Poor	Shoals	no	NA	10
Somewhat Poor	Shoals	no	NA	13
Somewhat Poor	Shoals	no	NA	19

Table 8. Soil Drainage Classes Investigated within the Research Universe.				
Drainage	**Soil Series**	**Artifacts**	**Depth (cm)**	**Investigation Area**
Somewhat Poor	Shoals	no	NA	22
Somewhat Poor	Tice	no	NA	6
Somewhat Poor	Tice	no	NA	6
Moderately Well	Eel	no	NA	24
Well	Ross	no	NA	8
Well	Ross	yes	20-100	16
Well	Chagrin	no	NA	10
Well	Chagrin	no	NA	11
Well	Chagrin	no	NA	23
Well	Genesee	yes	26-76	1
Well	Genesee	no	NA	2
Well	Genesee	no	NA	12
Well	Genesee	no	NA	14
Well	Genesee	yes	45	15
Well	Genesee	no	NA	17
Well	Genesee	no	NA	18
Well	Genesee	no	NA	20
Well	Genesee	no	NA	25
Well	Genesee	no	NA	26
Well	Genesee	yes	20-100	16
Well	Genesee	no	NA	21
Well	Piankeshaw	no	NA	4
Well	Battleground	yes	80-170	7
Well	Battleground	no	NA	6
Well	Landes	yes	20-120	9
Well	Landes	yes	55	5
Well	Fox	no	NA	23
Well	Rush	yes	20-80	3
Well	Stonelick	no	NA	11

The drainage characteristics of soils appears to have a strong correlation with the potential for the discovery of buried artifacts. None of the investigations conducted within the research universe on poorly drained soils discovered any buried artifacts. Only those soils listed as well drained contained buried artifacts.

As mentioned in the background section, these correlations are reflections of patterned behaviors. It is an axiom of archaeology that sites with the lowest potential for flooding that are near water sources contain the highest density of occupation (for examples see O'Brien and Wood 1998; Pollack 1990; Winters 1969). Many studies have demonstrated the low potential for sites to be found in poorly drained soils (for an example see McCord et al. 2007). It appears that what is known from surface sites also corresponds to buried sites.

As previously stated in the biases within subsurface investigations within the state of Indiana, there is a perception of an increase in the potential for buried deposits within larger order stream valleys. As no stream order map of the state of Indiana is available, an attempt was made to create one utilizing ArcGIS software and shapefiles available from the United States Geological Survey (USGS). The shapefiles available from the USGS were not originally created in a manner that allowed for the production of a stream order attribute. The simplest method then was to break down the stream orders within the research universe into much less strictly defined orders than either Strahler (1957) or Shreve (1966) methods allow. The classification listed as tributary refers to what would commonly be called first and second order streams. These are perennial streams near the headwaters of a drainage basin that are fed only by other streams of like magnitude. The classification listed as creek refers to what would commonly be called third and fourth order streams. These are fed by multiple tributaries and other small creeks. They are less than the main branches of large drainage basins. The classification listed as river refers to what would commonly be called fifth and higher stream orders. These are the main branches of large drainage basins. Because of the loose application of stream order, the analysis should not be construed as definitive. However, based on these results it appears that there is not a correlation between stream order and the potential for buried archaeological sites (Table 9). The data clearly demonstrates that small stream orders cannot be categorically excluded from subsurface investigation. In the streams classified as rivers the greatest depth to buried artifacts was 170 cm and the average depth was approximately 70 cm. In the streams classified as creeks only one area contained buried deposits, with the potential for deposits from 20 to 120 cm. In the streams classified as tributaries the depths of artifacts ranged from 26 to 76 cm with an average of approximately 55 cm. From the current results it appears that there is a difference in the depth of buried deposits based on stream order, but not a significant difference in the potential for an area to contain buried deposits.

Table 9. Stream Orders Investigated within the Research Universe.

Magnitude	**Artifacts**	**Area**
River	No	4
River	No	6
River	No	8
River	No	12
River	No	17
River	No	18
River	No	19
River	Yes	3
River	Yes	7
River	Yes	15
River	Yes	16
Creek	No	10
Creek	No	11
Creek	No	13
Creek	No	14
Creek	No	20
Creek	Yes	9
Tributary	No	2
Tributary	No	21
Tributary	No	22
Tributary	No	23
Tributary	No	24
Tributary	No	25
Tributary	No	26
Tributary	Yes	1
Tributary	Yes	5

Another measurement that was recorded from the subsurface investigation areas was the distance to the water source (Table 10). It was unknown whether the distance to the water source would affect the potential for buried sites. While surface sites are many times located near water sources, it was unknown whether these sites might be exposed to increased erosion and instability caused by natural stream migration within the channel. The results are inconclusive as there were not enough investigation areas to make a determination, although approximately 25 percent of the areas within 20 meters of the stream channel contained buried deposits. This was statistically no different than the average for all areas which was approximately 23 percent.

Table 10. Proximity to Water of Investigation Areas within the Research Universe.

Proximity (in meters)	Artifacts	Area
10	No	10
20	No	18
20	No	13
20	No	14
20	No	20
20	Yes	9
20	No	23
20	No	24
20	No	26
20	Yes	1
20	Yes	5
20	No	25
50	No	11
70	No	17
75	No	22
90	No	21
100	No	19
100	Yes	16
100	No	2
150	No	4
180	No	12
200	Yes	7
200	Yes	15
350	No	6

Chapter 6. Conclusions

Subsurface investigation is an important site discovery technique employed in areas that have the potential to contain intact buried archaeological deposits. This thesis reviewed and analyzed literature from Indiana archaeological reports to investigate site burial potentials within the Tipton Till Plain region of Indiana. The goal was to provide a simple method of predicting the potential for buried deposits within alluvial settings. The current recommendation for subsurface investigation is typically based on the presence of well drained low energy alluvial, colluvial or aeolian deposits.

Multiple attributes were analyzed to test for a predictive method of determining the potential for intact buried deposits within the Tipton Till Plain in Indiana. The analysis of soil permeability in relation to the wider upstream drainage basin failed to provide any predictive value. It may be that the hypothesis behind the methods employed was incorrect, or the level of specificity within the county soil maps utilized in the analysis was insufficient for the analysis undertaken. The analysis of valley width ratios preliminarily appears to indicate that subsurface materials are more likely to be encountered in valleys with stable widths upstream from the investigation area. If additional studies support this assertion, this could be a useful analytical tool as the analysis of a given area is fairly simple.

The two somewhat correlated attributes—soil taxonomy and soil drainage—appear to be predictors of where sites are not likely to occur. This corroborates previous research (Brown 1991; Carr 1985; Ebert 1988; Jochim 1976; Plog and Hill 1971). Soils with a high water table and soils with poor drainage characteristics are not likely to contain buried deposits.

The data also indicates that the perceptual bias against the potential of smaller order streams to contain buried deposits is erroneous. Buried sites appear to be as frequent within smaller stream order valleys as they are in the larger river valleys, although they may not occur at as great of depths. Finally, the analysis of the potential of an area to contain buried deposits does not appear to be different based on variations in the proximity to the water source.

As subsurface testing has evolved, the methods of reporting results has also evolved. The standardization of reporting may lead to greater understanding in the future. Additional research into other factors that can lead to a higher rate of buried site discovery is recommended. Based upon the results of the current study it is suggested that recommendations for subsurface investigations should continue to be made according to the current guidelines. The guidelines have not always been followed, many times at the request of the lead agency. Based upon the results of this study the inclusion of poorly drained soils recommended for subsurface investigation appears to be without justification. Additionally, it is recommended that future subsurface investigations should target Mollisols over Inceptisols. The successful identification of factors that can lead to intact subsurface deposits still remains in a large part contingent on the county soil maps and the common sense of the individual archaeologist in the field.

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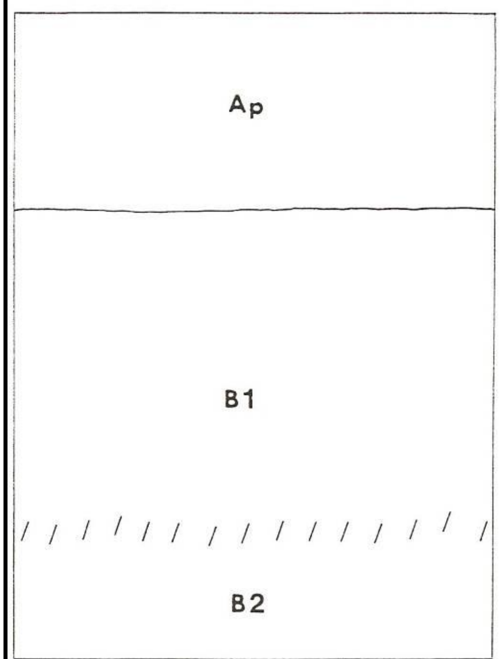
PREDICTING BURIED SITES: ANALYSIS OF THE TIPTON TILL PLAIN REGION OF INDIANA.

APPENDIX A. INVESTIGATION AREA DESCRIPTIONS

Investigation Area 1

Investigation area 1 is located in Huntington County (Zoll 1991). The original survey showed the potential for intact buried deposits based upon the general soils maps. The soil within the project area is Genesee silt loam. It is unknown whether bucket augers were utilized to verify the presence of well drained alluvium (Zoll 1989). The subsurface reconnaissance was conducted to both the east and west edge of the stream. A total of three trenches were excavated within the project area. The trenches revealed sand lenses between silt loams indicating high energy episodes. A trench profile showing the sediments discovered is included below (Figure 1). Artifacts were recovered from one of the trenches between 26 and 76 cm below ground surface. The artifacts were limited to flakes and fire-cracked rock. No diagnostic artifacts were recovered and no features were encountered. The subsurface site was not considered eligible for listing on the State or National Registers. The width of the stream valley at the location of the project area is 400 m (Figure 2).



Deep Trench 3
Description

Ap- 0 to 29cm, 10YR3/3, silty clay loam, subangular blocky moderate structure, abrupt smooth boundary.

B2- 29 to 77cm, 10YR4/3, silty clay, subangular blocky moderate structure, diffuse wavy boundary.

B3- 77 to 96+cm, 10YR5/3, silty clay, subangular blocky moderate structure.

Figure 10. Profile of typical trench in Subsurface Area 1 (Zoll 1991).

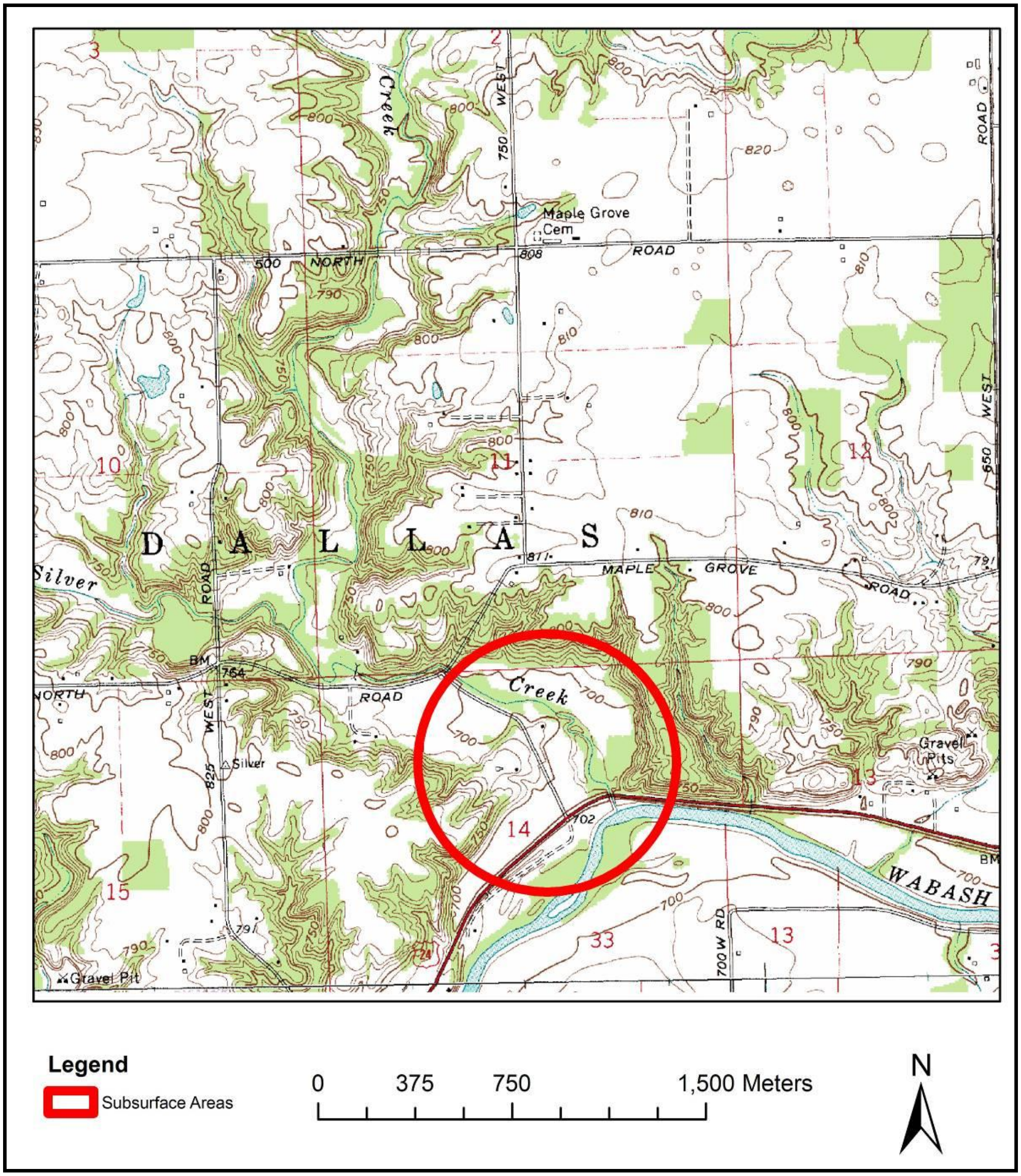


Figure 11. Subsurface Area 1 as shown on the USGS 7.5' series Bippus, Indiana quadrangle.

Investigation Area 2

Investigation area 2 is located in Huntington County (Zoll 2001). The original survey showed the potential for intact buried deposits based upon the general soils maps. The soil within the project area was Genesee silt loam. A total of four bucket augers were excavated within the project area to sample the subsoil sediments and to assess the potential for intact buried deposits (Martin 2000). The subsurface reconnaissance was conducted at the northern edge of the valley. A total of two trenches were excavated within the project area. The trenches within the project area revealed sandy soils indicative of high energy deposition. A trench profile showing the sediments discovered is included below (Figure 3). The width of the stream valley at the location of the project area is 370 m (Figure 4). This portion of the valley is located just north of the valley of the Wabash River.

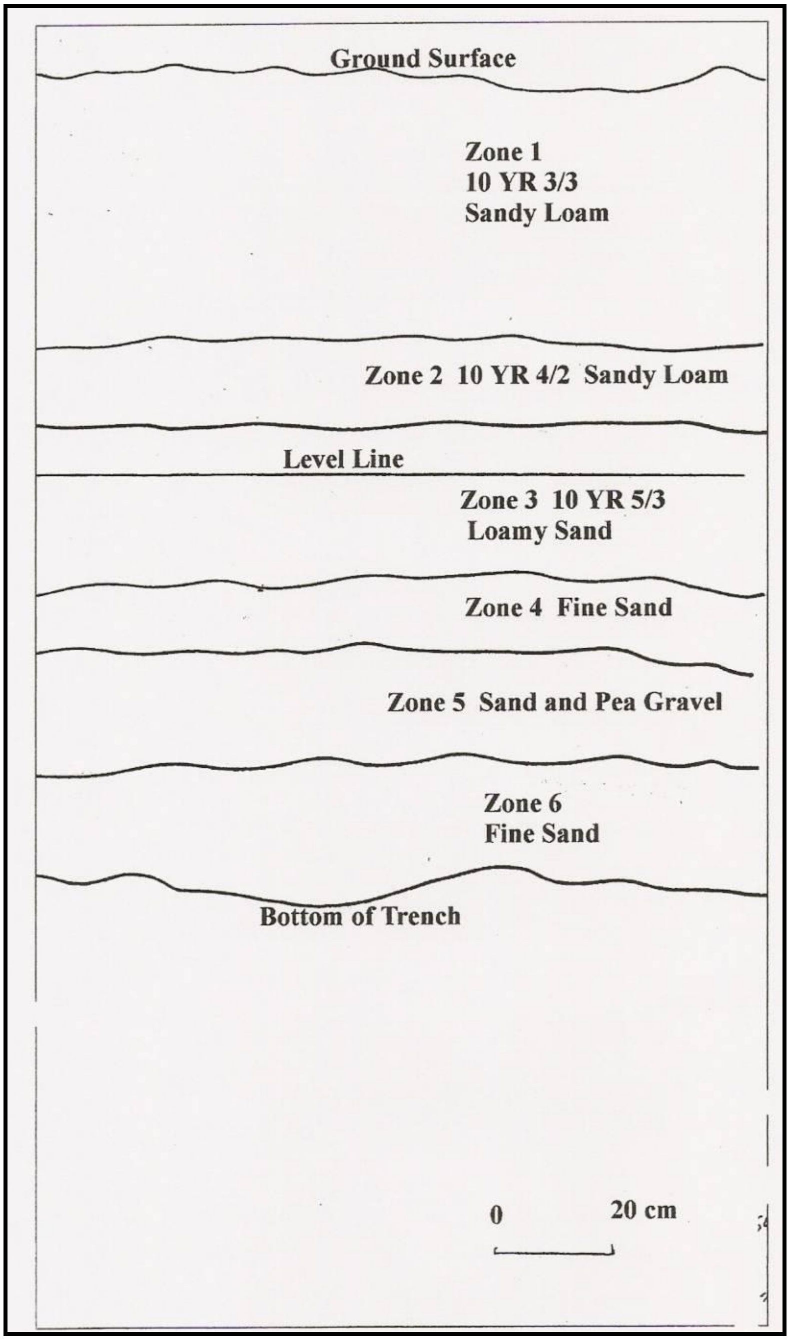


Figure 12. Profile of typical trench in Subsurface Area 2 (Zoll 2001).

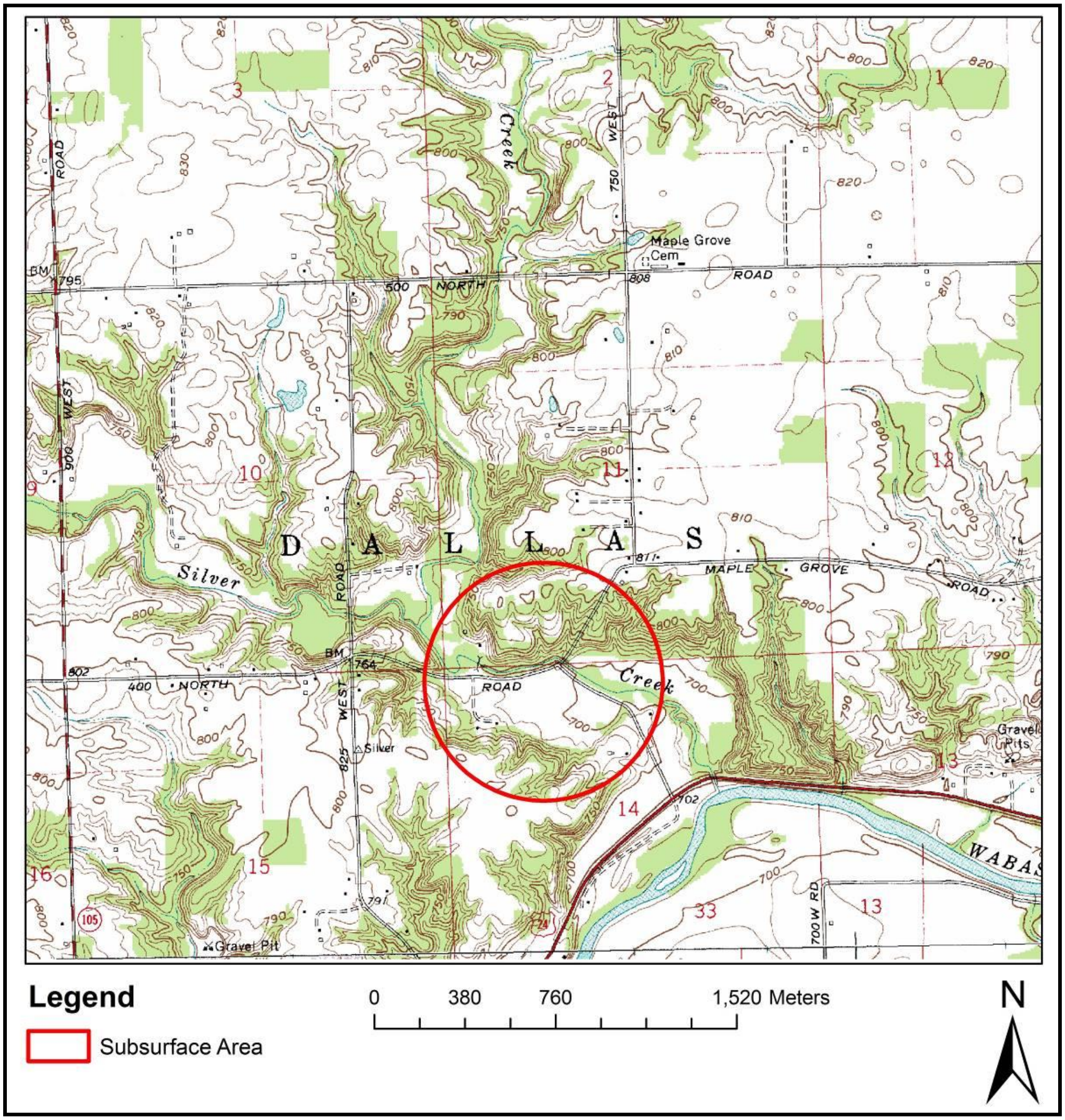


Figure 13. Subsurface Area 2 as shown on the USGS 7.5' series Bippus, Indiana quadrangle.

Investigation Area 3

Investigation area 3 is located in Cass County (Maust 1988). The original survey showed the potential for intact buried deposits based upon the general soils maps. The soil within the project area is Rush silt loam. It is unknown whether bucket augers were utilized to verify the presence of well drained alluvium. The subsurface reconnaissance was conducted within the floodplain of the Wabash River. A total of four trenches were excavated within the project area. Artifacts were recorded to a depth of 65 cm below ground surface. No intact features or diagnostic artifacts were recovered from the trench. The trenches within the project area revealed sandy deposits indicating high energy deposition. A trench profile showing the sediments discovered is included below (Figure 5). Artifacts were recovered from one of the trenches at 65 cm below ground surface. The artifacts were limited to three flakes. No diagnostic artifacts were recovered and no features were encountered. The subsurface site was not considered eligible for listing on the State or National Registers. The width of the stream valley at the location of the project area is 2060 m (Figure 6).

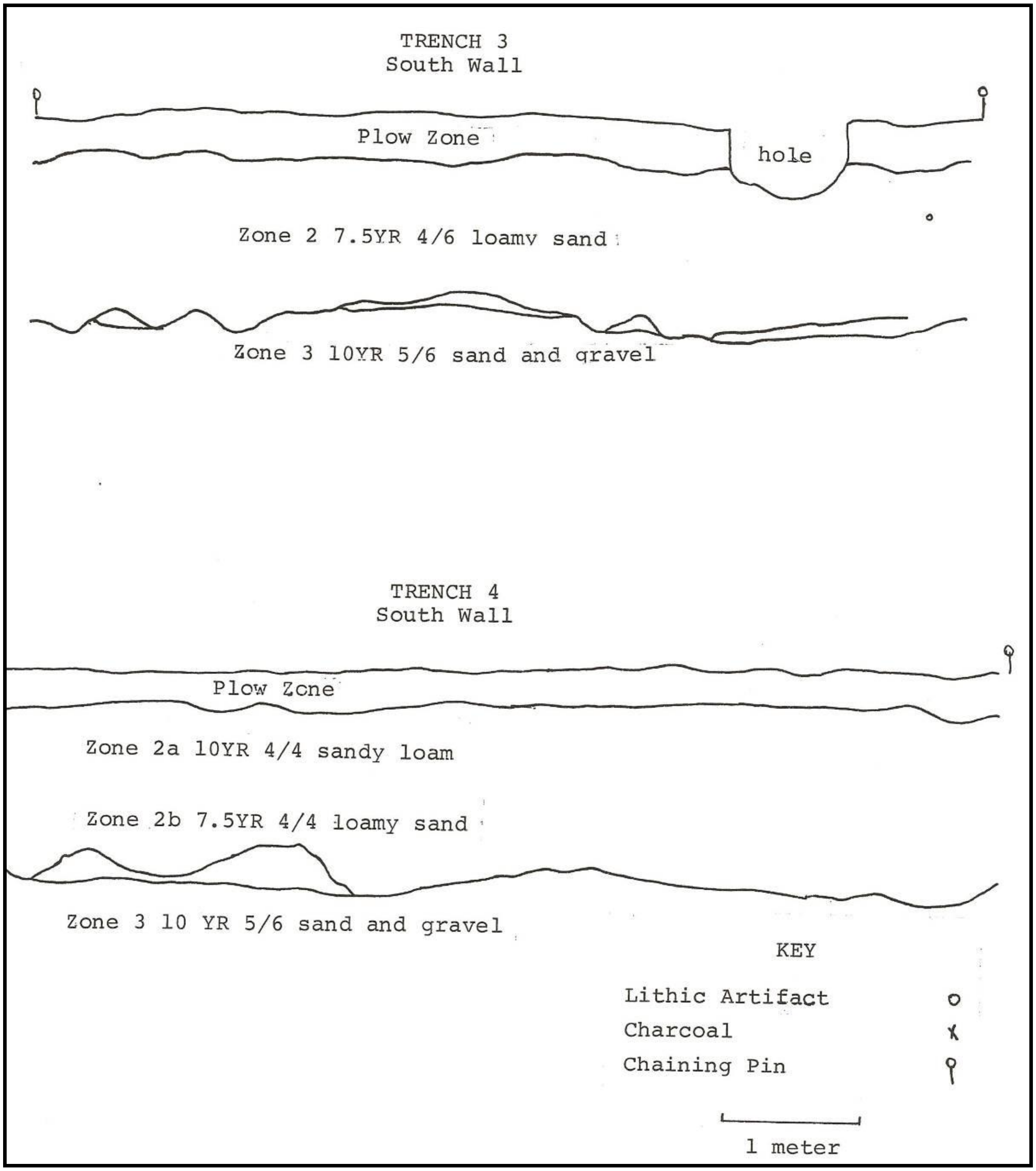


Figure 14. Profiles of typical trenches in Subsurface Area 3 (Maust 1988).

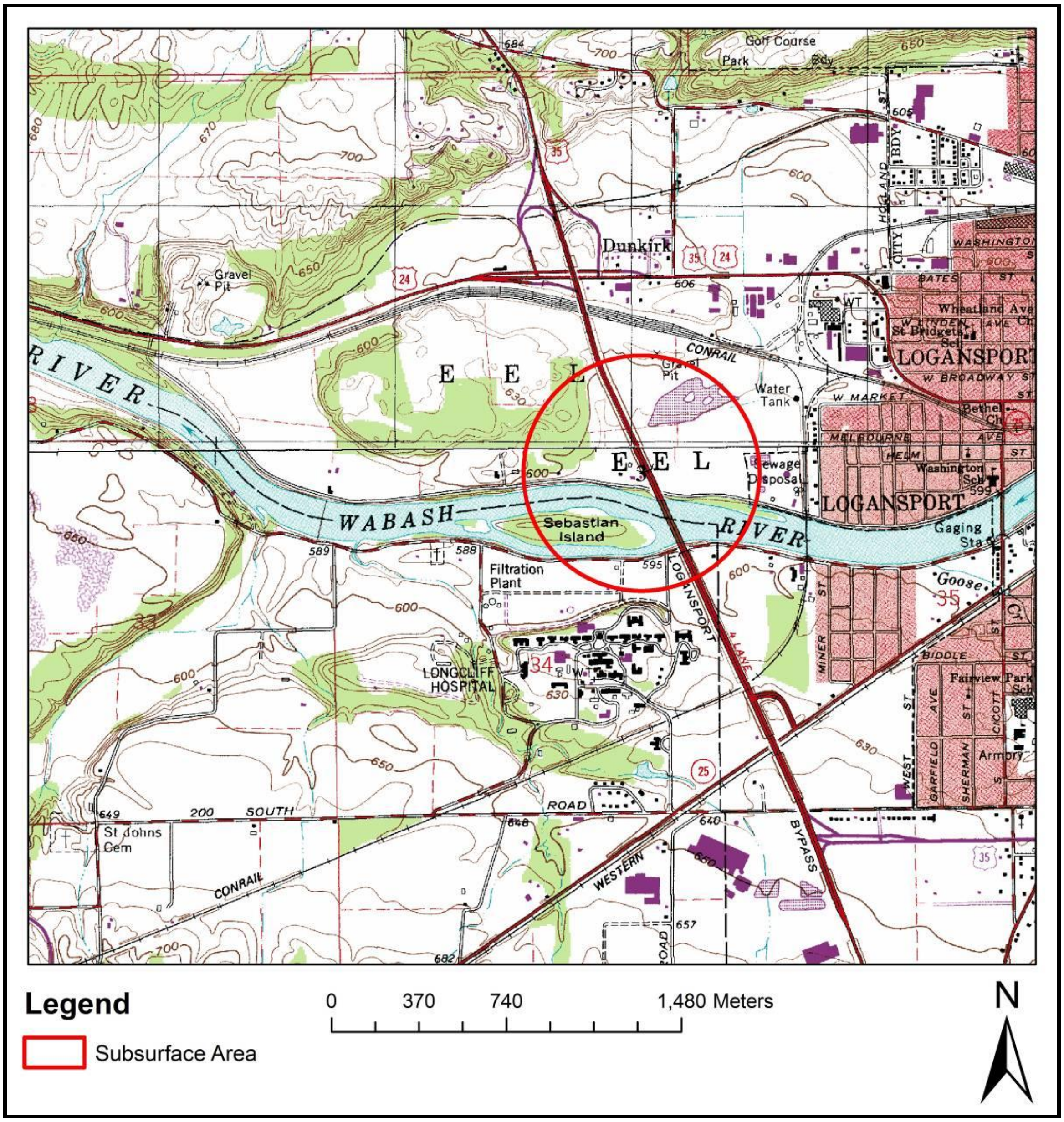


Figure 15. Subsurface Area 3 as shown on the USGS 7.5’ series Bippus, Indiana quadrangle.

Investigation Area 4

Investigation area 4 is located in Carroll County (Bubb 2005). The original survey showed the potential for intact buried deposits. The soils within the project area are Piankeshaw Variant gravelly sandy loam and Cohoctah Variant sandy loam which form on alluvial fans and floodplains respectively. A total of four bucket augers were excavated to sample the nature of the soils (Bubb 2004). Bucket augers confirmed the presence of well drained alluvium and a subsurface investigation was undertaken. The subsurface reconnaissance was conducted at the extreme western edge of the valley. Because of the size of the project area only two trenches were opened within the project area. The trenches revealed highly active depositional characteristics. One trench within the project area collapsed because of the high sand content. Additionally, the water table was hit at a depth of 1 m. No profiles of trenches were included in the report. The width of the Wabash River valley at the location of the project area is approximately 2.6 kilometers (Figure 7).

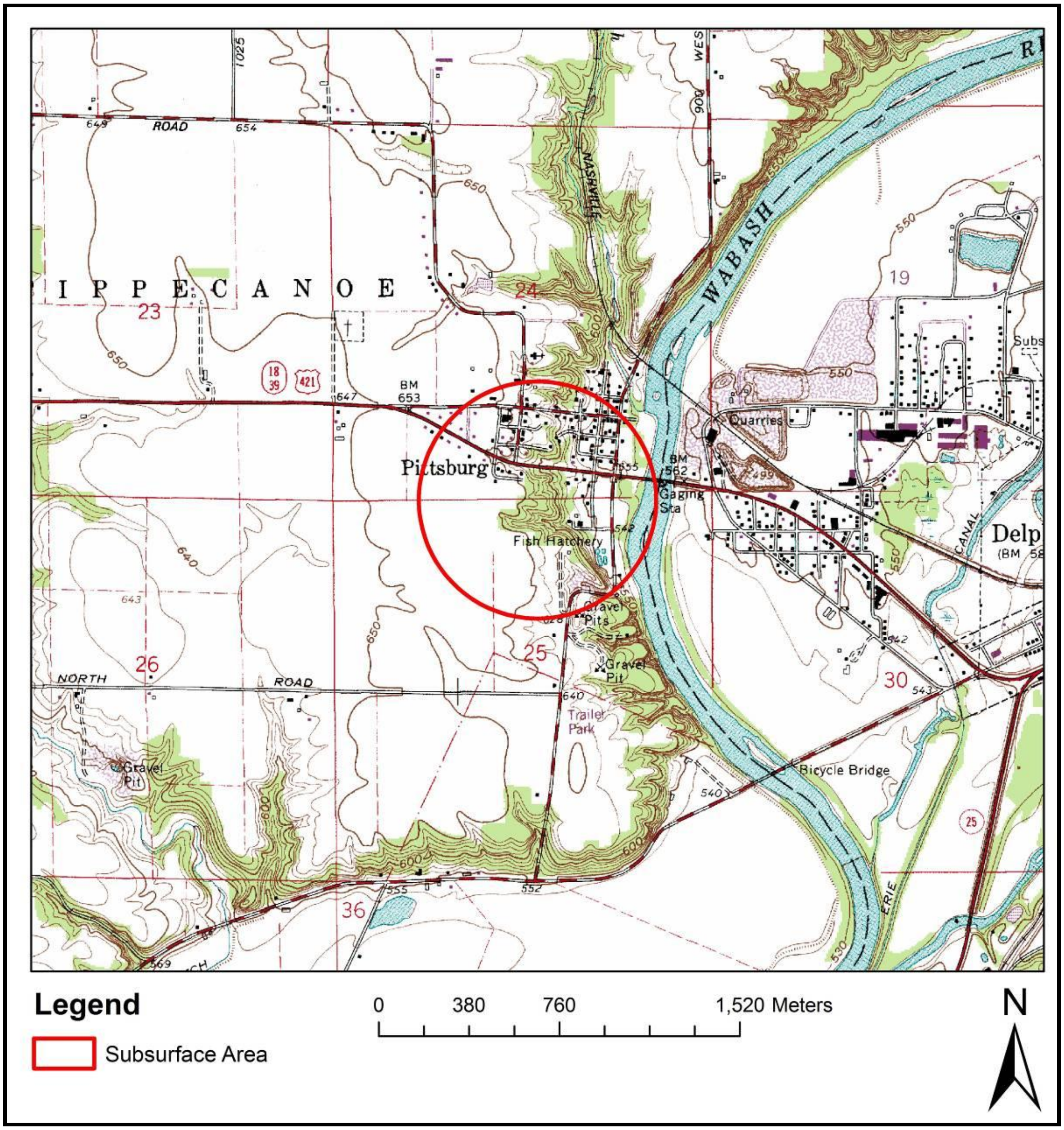


Figure 16. Subsurface Area 4 as shown on the USGS 7.5’ series Delphi, Indiana quadrangle.

Investigation Area 5

Investigation area 5 is located in Grant County (Angst 1997a). The original survey showed the potential for intact buried deposits. The soil within the project area is Landes sandy loam. A total of three bucket augers were utilized to confirm the presence of well drained alluvium and a subsurface investigation was recommended (Angst 1997c). The subsurface reconnaissance was conducted near Lugar Creek in the middle of the valley. A total of five trenches were excavated. The trenches within the project area revealed well drained alluvium and a buried A-horizon. Within the buried A-horizon was a scattering of 2 flakes, a biface and 13 pieces of FCR. No features were discovered within or on the buried A-horizon. The components collected were not diagnostic of any time period and could only be categorized as prehistoric. The buried A-horizon was discovered at a depth of approximately 55 cm. A trench profile showing the sediments discovered is included below (Figure 8). The width of the stream valley at the location of the project area is 290 m (Figure 9). The investigation area is just upstream from the confluence of Lugar Creek and an unnamed stream. The soils encountered did not conform with the county soils maps which indicated the presence of a sandy loam within the project area. Instead silt loams and clay loams were encountered.

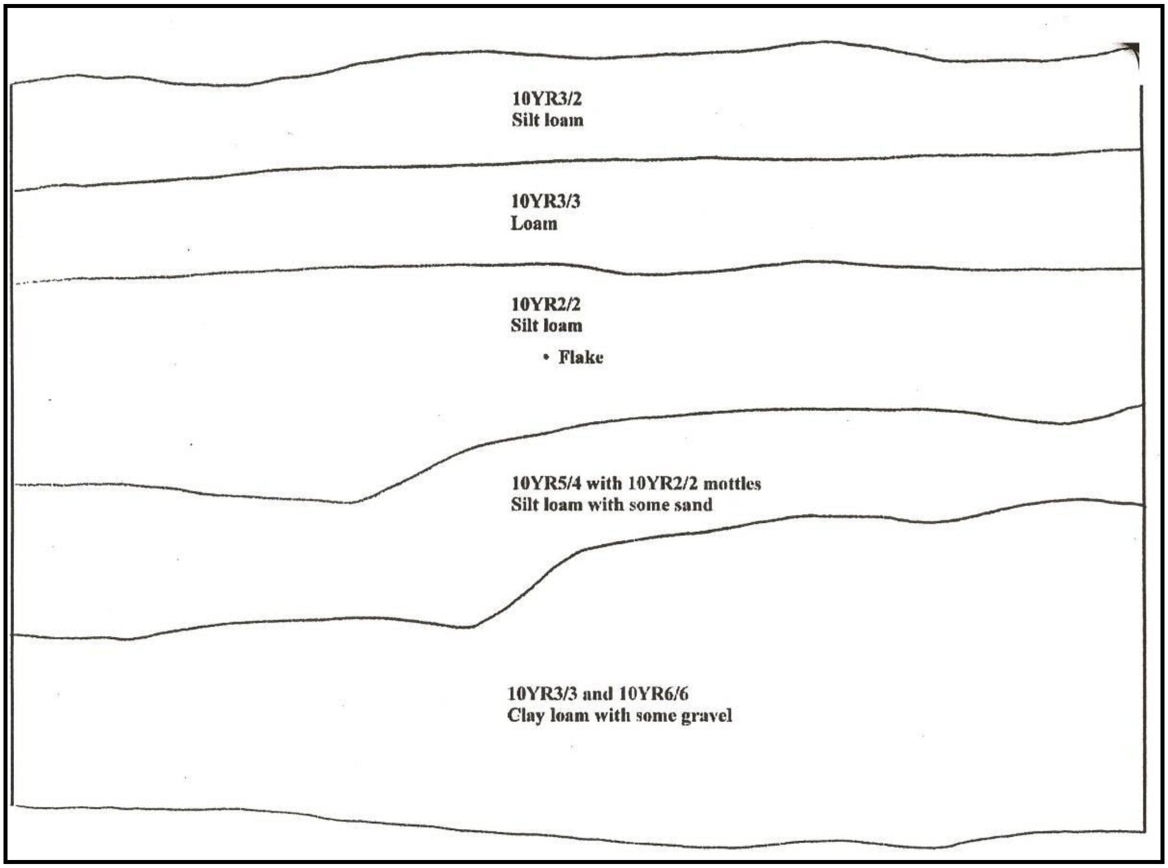


Figure 17. Profile of typical trench in Subsurface Area 5 (Angst 1997a).

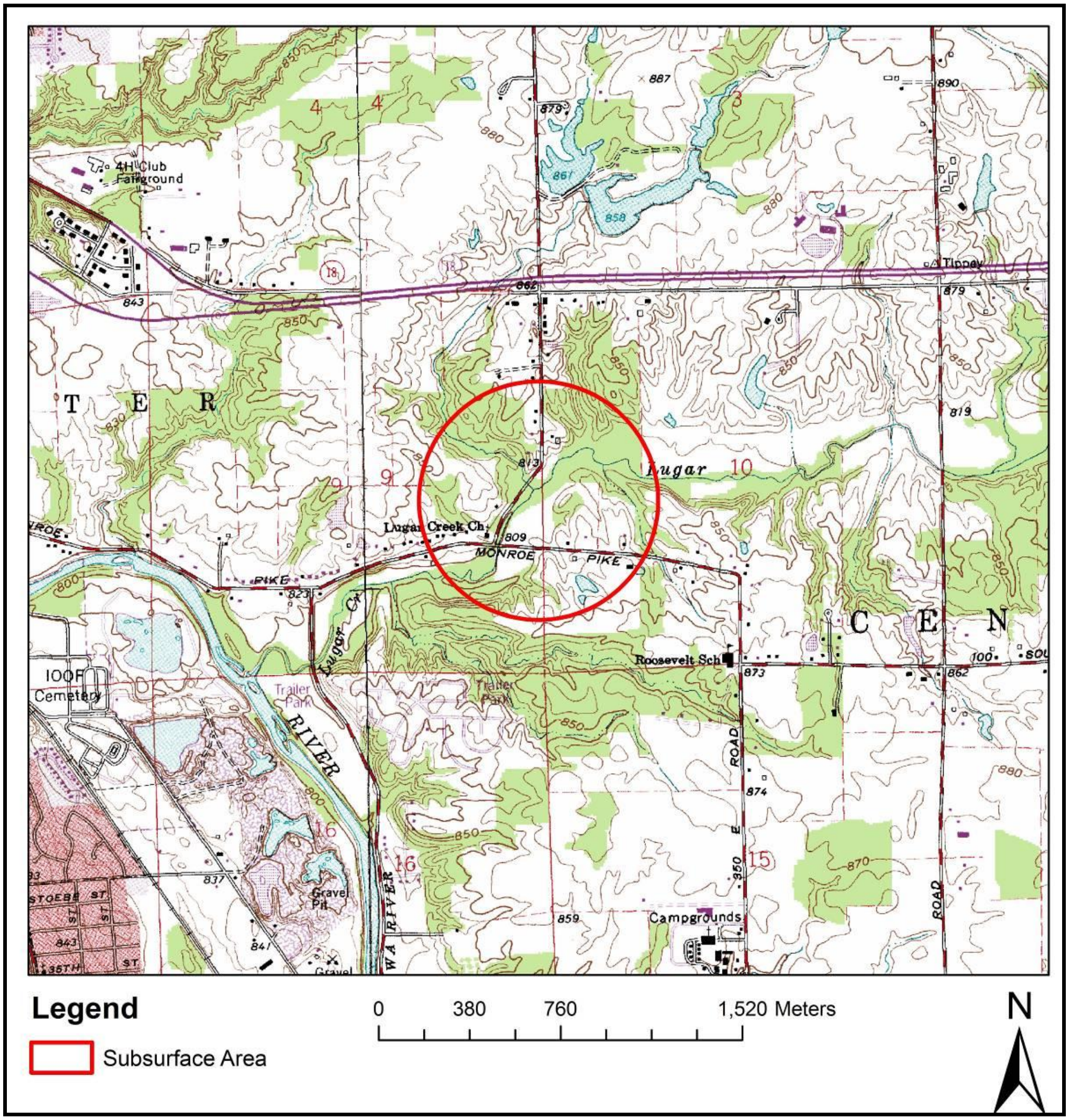


Figure 18. Subsurface Area 5 as shown on the USGS 7.5' series Van Buren and Marion quadrangles.

Investigation Area 6

Investigation area 6 is located in Tippecanoe County (Zoll 1999a). The original survey showed the potential for intact buried deposits. The soils within the project area are Battleground silt loam and Tice silty clay loam, frequently flooded. Approximately fifteen bucket augers were excavated within the project area (Smith 1999). The bucket augers confirmed the presence of well drained alluvium and a subsurface investigation was undertaken. The subsurface reconnaissance was conducted from near the banks of the river out toward the outwash terrace. A single trench was excavated within the project area. The trench revealed low energy alluvium with redoxymorphic features indicative of a fluctuating water table. A profile of a typical trench within the area is included (Figure 10). The width of the Wabash River valley at the location of the project area is 1380 m (Figure 11).

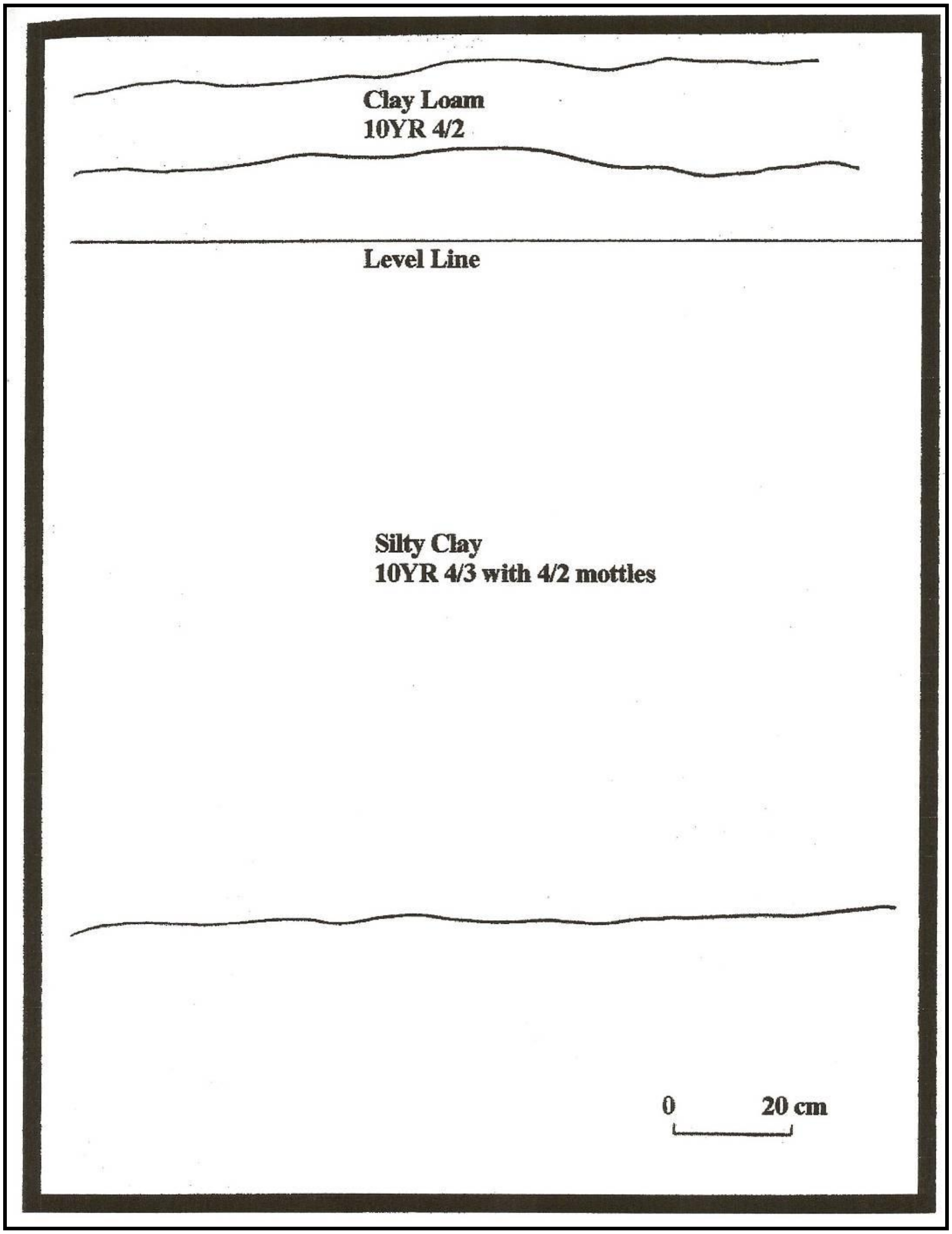


Figure 19. Profile of typical trench in Subsurface Area 6 (Zoll 1999a).

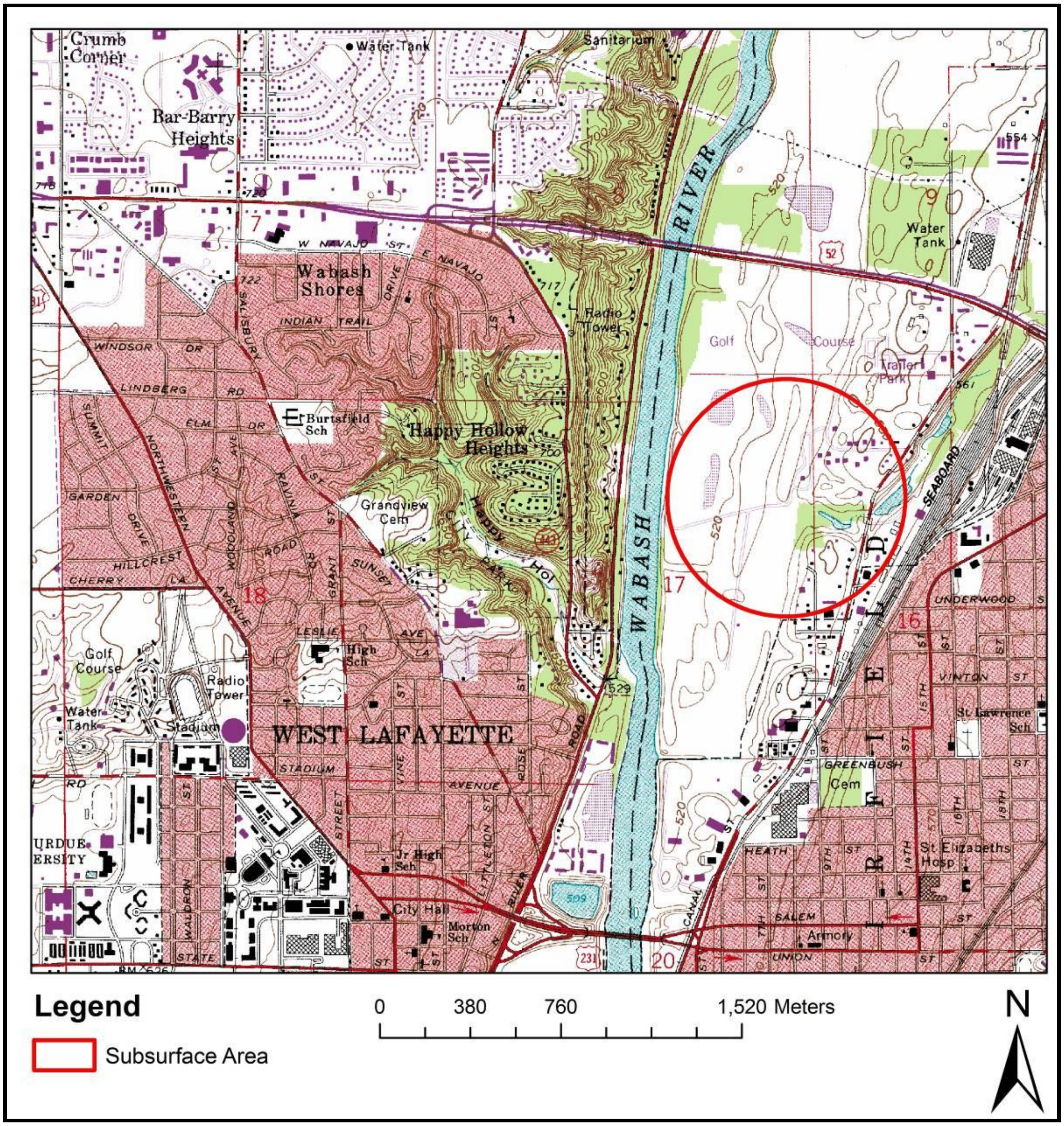


Figure 20. Subsurface Area 6 as shown on the USGS 7.5' series Lafayette West, Indiana quadrangle.

Investigation Area 7

Investigation area 7 is located in Tippecanoe County (McCord 1994b). The original survey showed the potential for intact buried deposits. The soil within the project area is Battleground silt loam. An unknown number of bucket augers were utilized to confirm the presence of alluvium and a subsurface investigation was undertaken. The subsurface reconnaissance was conducted along a parallel floodplain ridge. A total of three trenches were excavated. The trenches within the project area revealed fire cracked rock within a buried A horizon 0.8 to 1.7 m below ground surface. No diagnostic artifacts or culturally related charcoal were discovered within the buried A horizon. No identification in regard to date or cultural affiliation could be made from the deposits. In fact, with only fire cracked rock it is not entirely certain that the find represented an archaeological site, although the stable landform near the river likely indicates a utilized surface. A profile of a typical trench is included below (Figure 12). The width of the Wabash River valley at the location of the project area is approximately 1050 m (Figure 13).

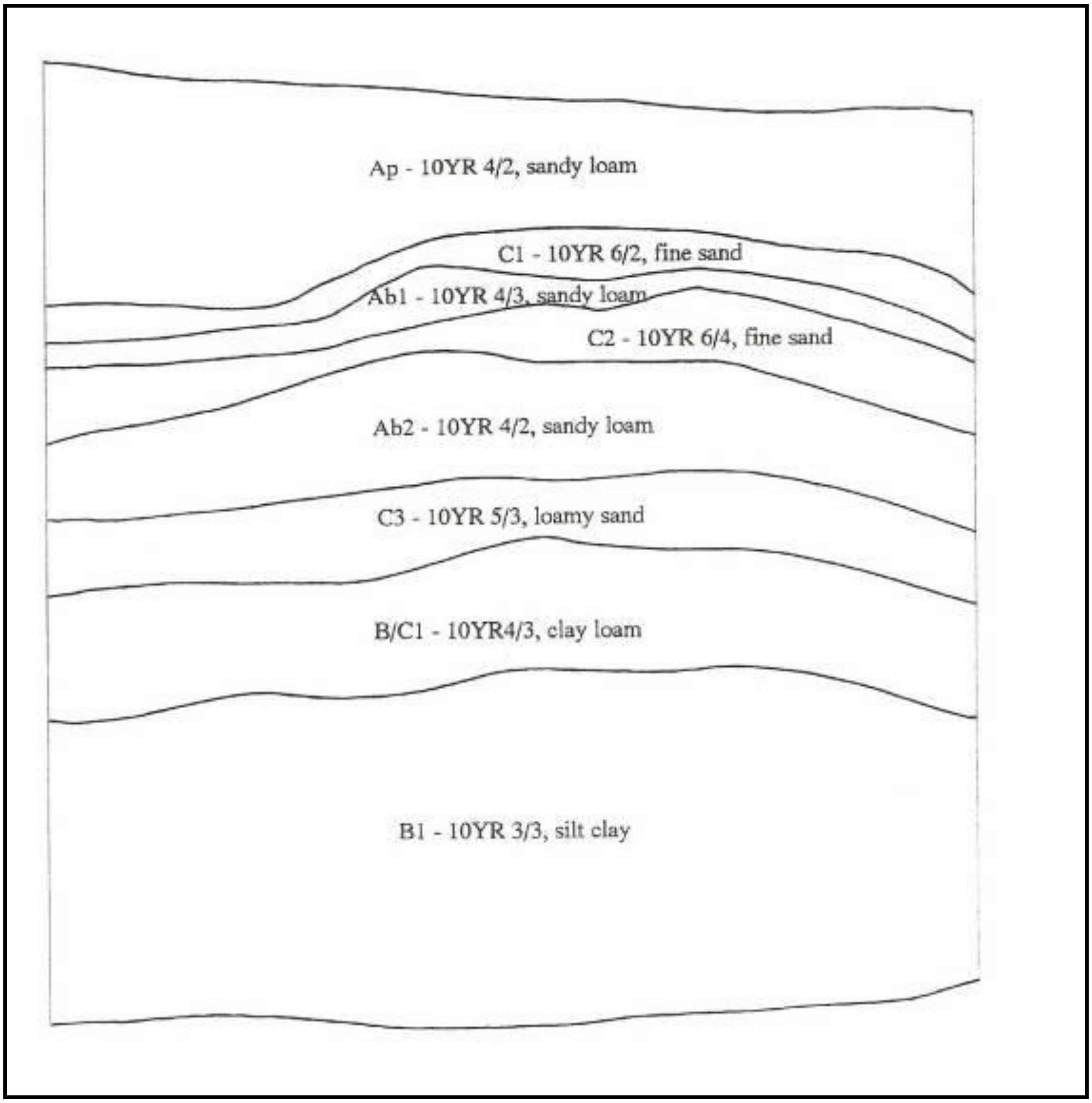


Figure 21. Profile of typical trench in Subsurface Area 7 (McCord 1994b).

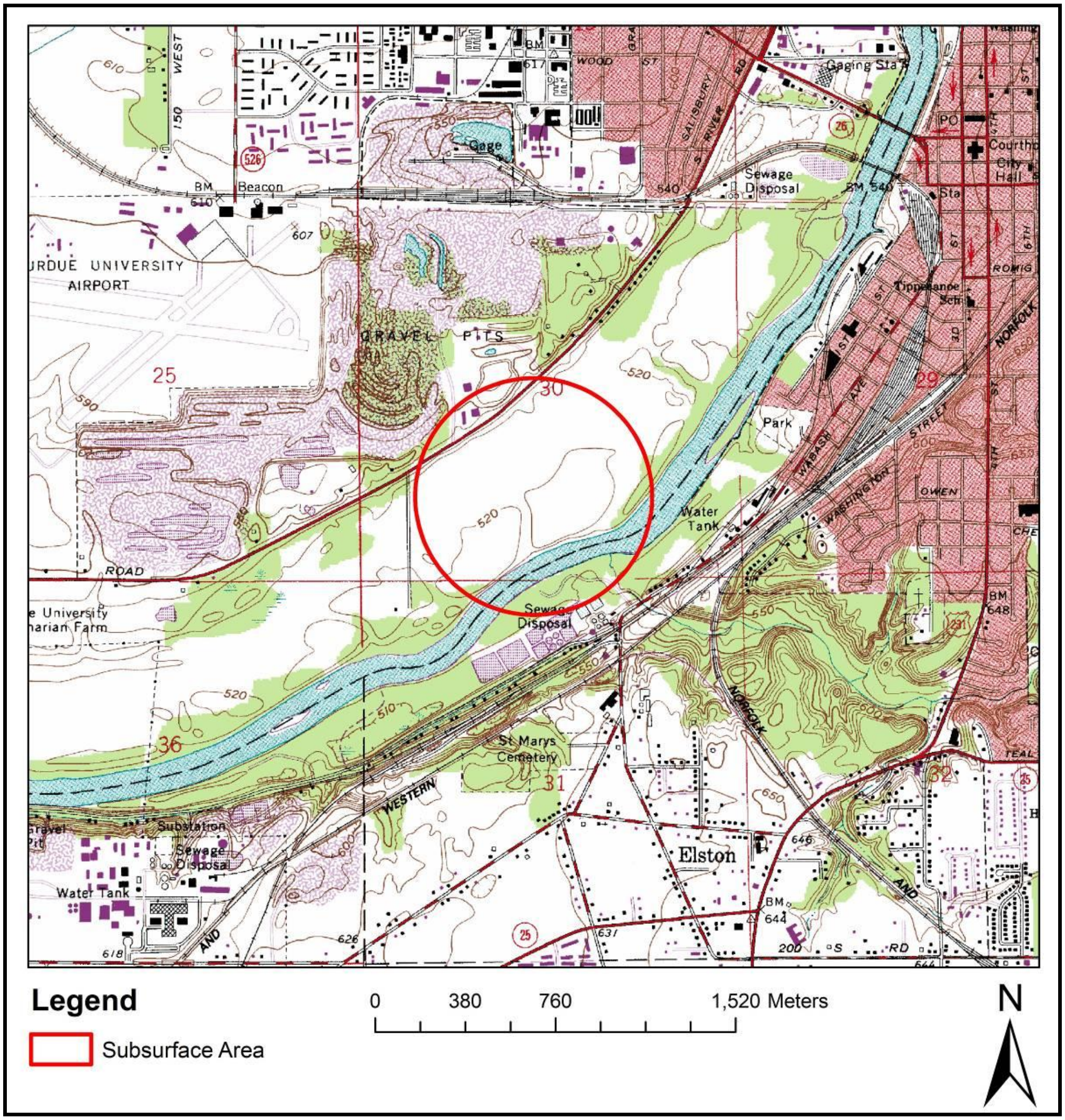


Figure 22. Subsurface Area 7 as shown on the USGS 7.5' series Lafeyette West, Indiana quadrangle.

Investigation Area 8

Investigation area 8 is located in Warren County (Kolbe 1993b). The original survey showed the potential for intact buried deposits. The soil within the project area is Du Page loam a competing series with Ross loams. A total of six bucket augers were utilized to confirm the presence of well drained alluvium and a subsurface investigation was recommended (Cantin 1993). The subsurface reconnaissance was conducted on a point bar near the stream. A total of three trenches were excavated. The trenches within the project area revealed high energy deposition with a thin cap of low energy alluvium. A trench profile showing the sediments discovered is included below (Figure 14). The width of the stream valley at the location of the project area is 380 m (Figure 15).

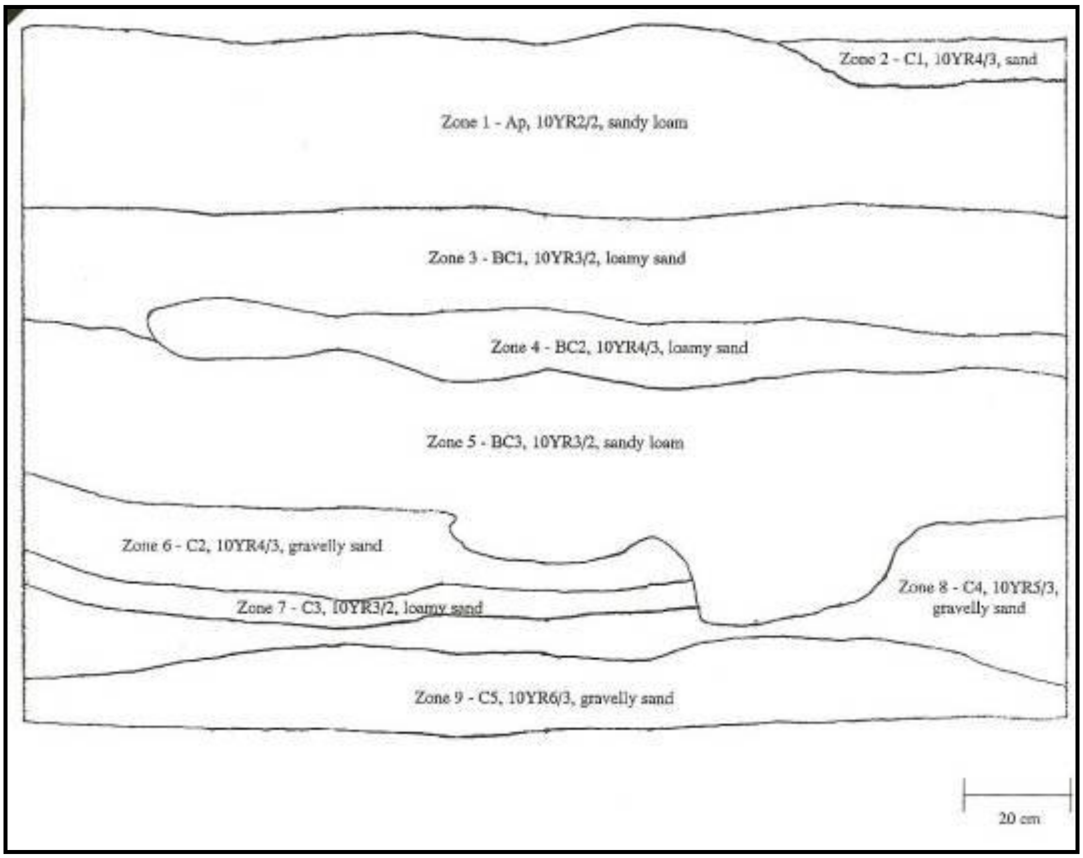


Figure 23. Profile of typical trench in Subsurface Area 1 (Kolbe 1993b).

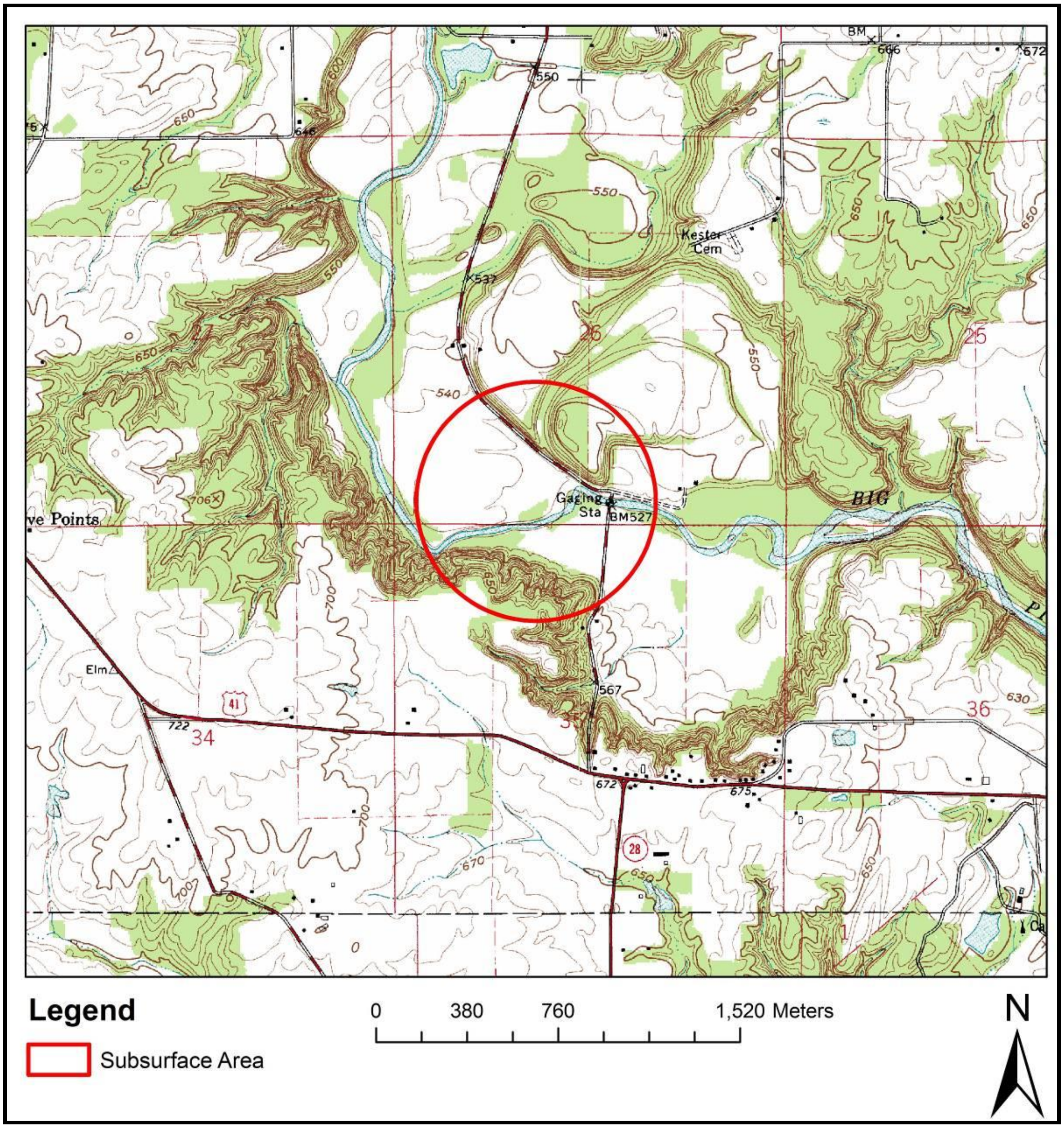


Figure 24. Subsurface Area 8 as shown on the USGS 7.5’ series Williamsport, Indiana quadrangle.

Investigation Area 9

Investigation area 9 is located in Montgomery County (McCord and Cochran 1994). The original survey showed the potential for intact buried deposits. The soil within the project area is the Landes variant. The mitigation was conducted adjacent to the stream channel. The stratigraphy of the project area revealed well drained, low energy alluvium. The site contained intact deposits that qualified for listing on the State and National Registers. The width of the stream valley at the location of the project area is 700 m (Figure 16).

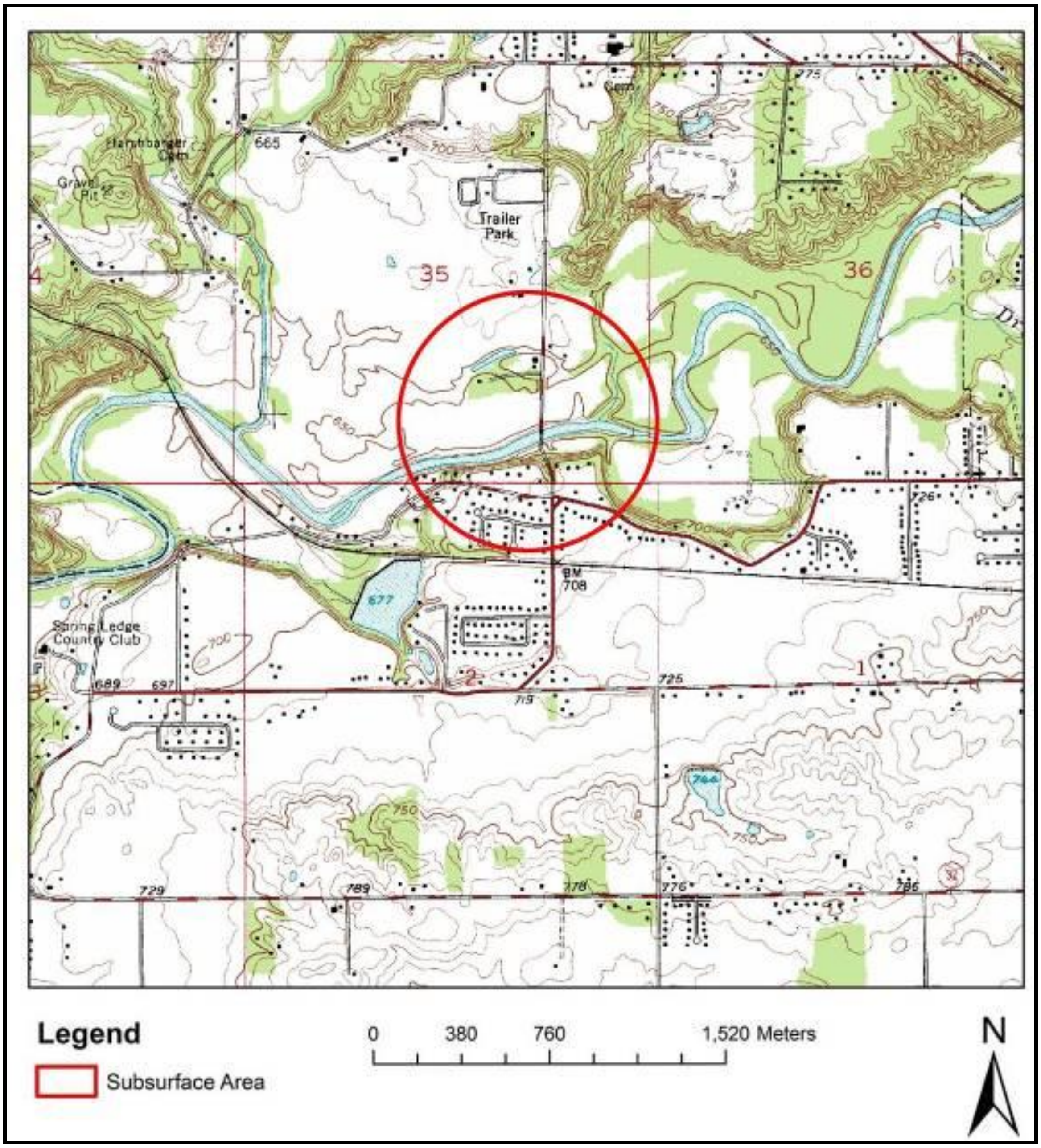


Figure 25. Subsurface Area 9 as shown on the USGS 7.5' series Crawfordsville, Indiana quadrangle.

Investigation Area 10

Investigation area 10 is located in Putnam County (Buechler 1994). The original survey showed the potential for intact buried deposits. The soils within the project area are Chagrin silt loam and Shoals silt loam. An unknown number of bucket augers were utilized to confirm the presence of well drained alluvium and a subsurface investigation was recommended. The subsurface reconnaissance was conducted in the middle of the valley. A total of three trenches were excavated. The trenches within the project area revealed high energy deposits. A trench profile showing the sediments discovered is included below (Figure 17). The width of the stream valley at the location of the project area is 590 m (Figure 18).

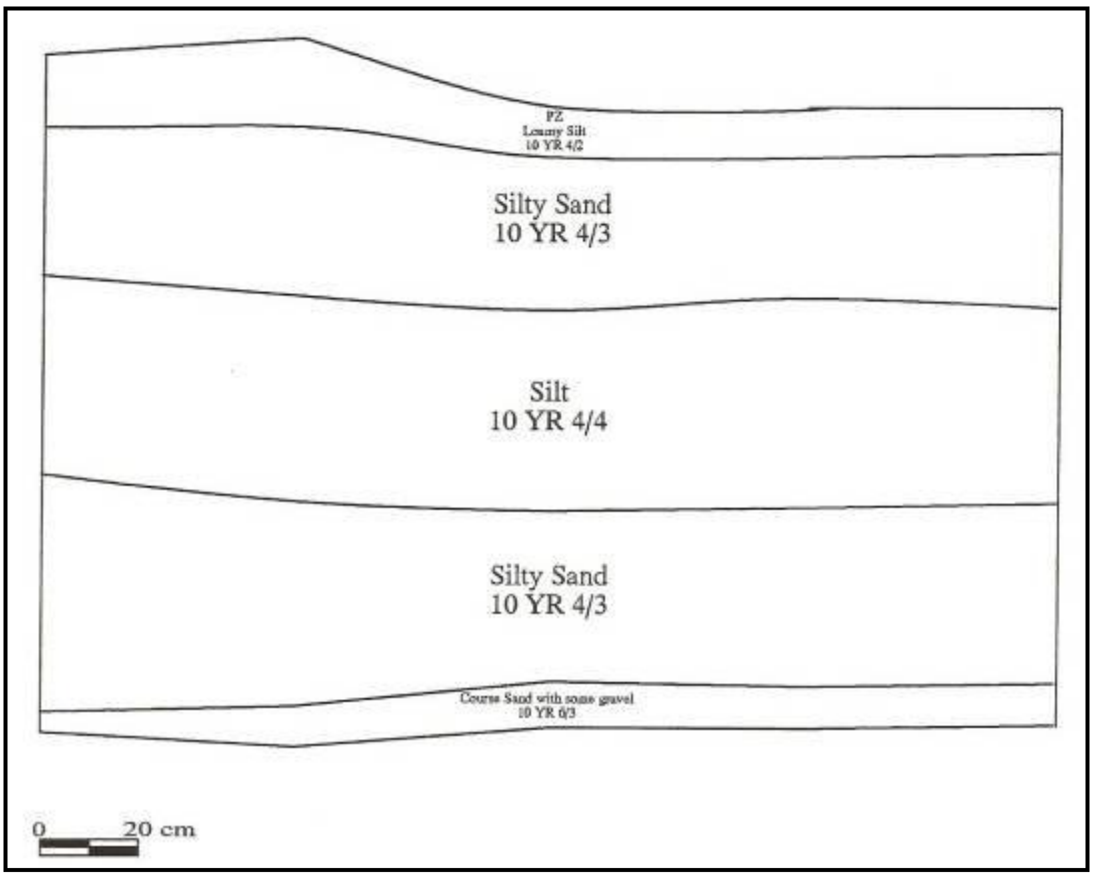


Figure 26. Profile of typical trench in Subsurface Area 10 (Buechler 1994).

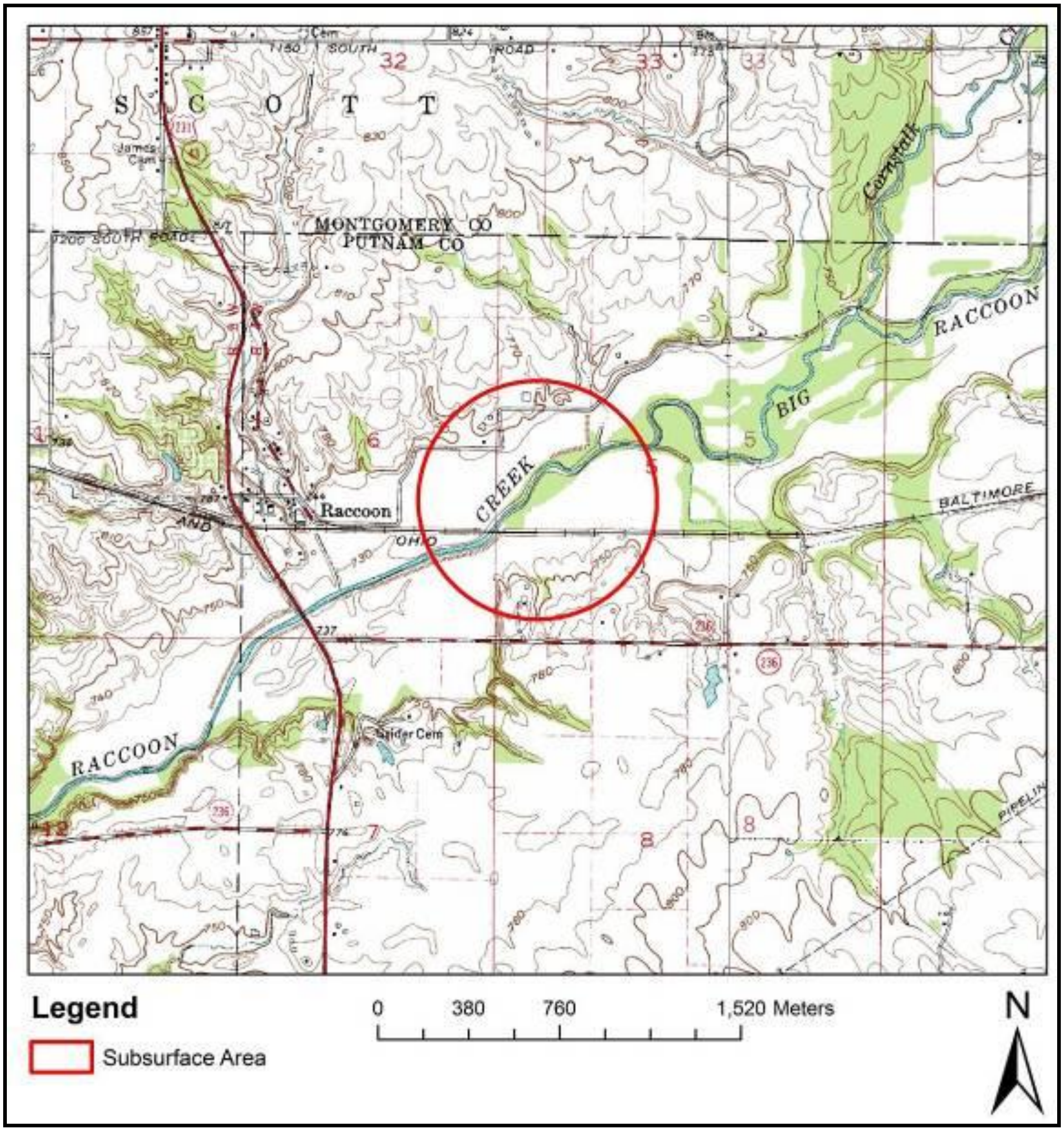


Figure 27. Subsurface Area 10 as shown on the USGS 7.5' series Roachdale and Russellville, Indiana quadrangles.

Investigation Area 11

Investigation area 11 is located in Putnam County (Zoll 2003). The original survey stated that the area had the potential for intact buried deposits. The soils within the project area are Chagrin silt loam and Stonelick sandy loam. While both soils form in alluvium the Stonelick series is almost always too high energy in deposition to preserve deposits. It is not apparent that any bucket augers or cores were utilized by the original survey crew in making the determination of the potential for intact deposits although a statement was made about loamy deposits to 48 inches below ground surface (Stillwell 2001b). The subsurface reconnaissance was conducted near the stream channel within the valley. The subsurface was conducted utilizing three backhoe trenches. They were excavated on both sides of the stream channel. The trenches within the project area revealed soils of highly active derivation. The soils within the trenches contained enough sand that they became unstable and collapsed. A trench profile showing the sediments discovered is included below (Figure 19). The width of the Big Walnut Creek valley at the location of the project area is approximately 750 m (Figure 20).

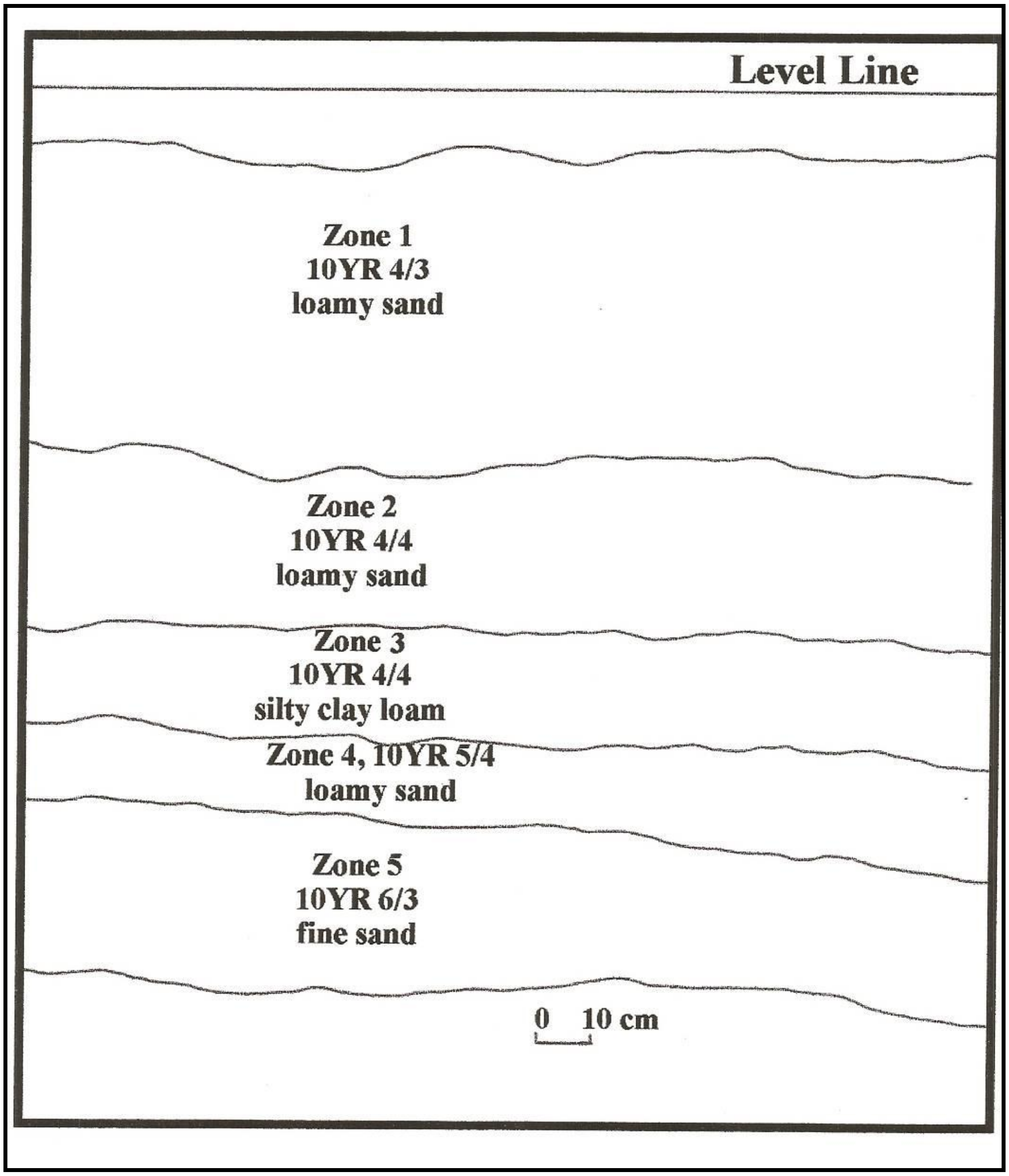


Figure 28. Profile of typical trench in Subsurface Area 11 (Zoll 2003).

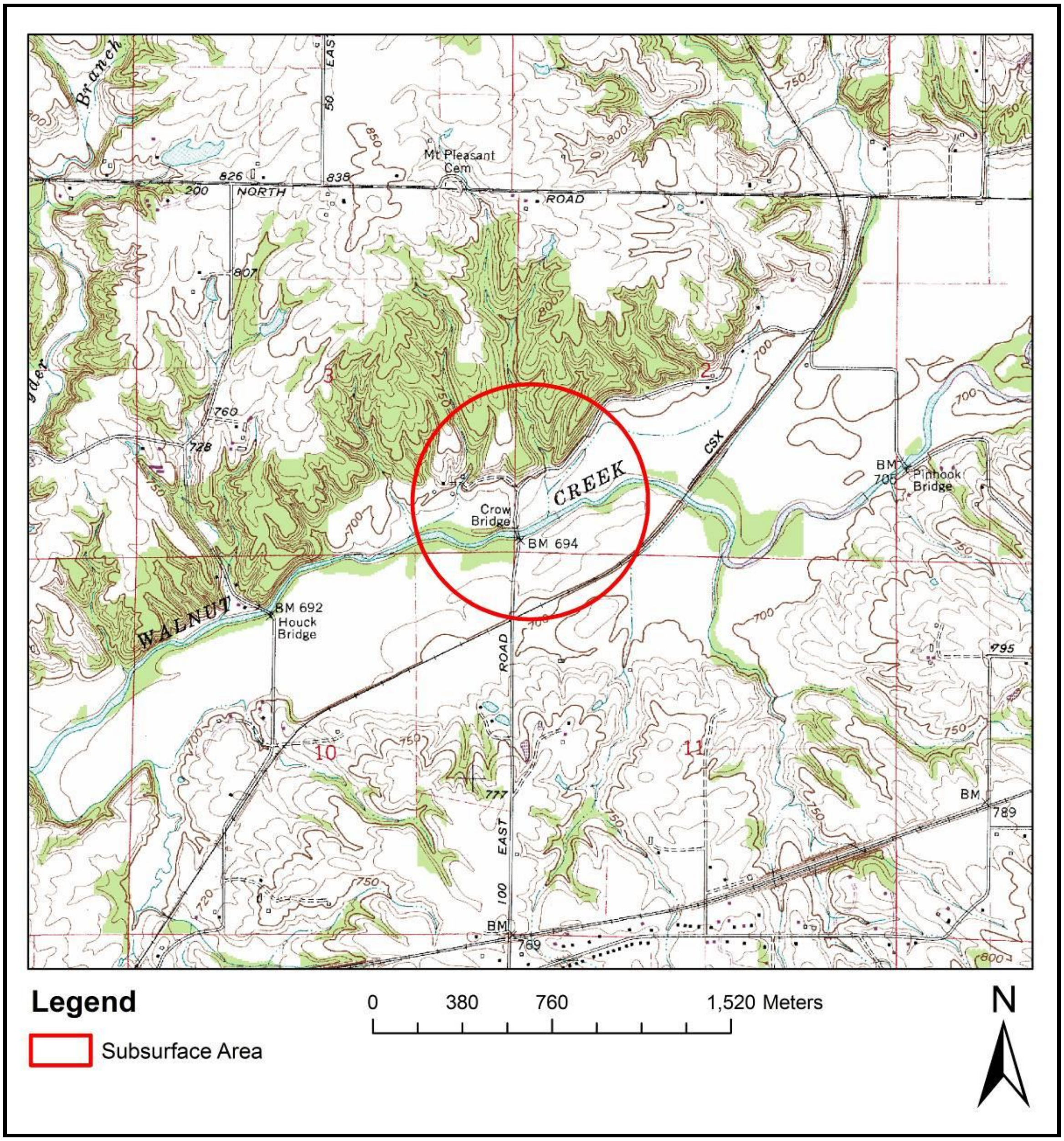


Figure 29. Subsurface Area 11 as shown on the USGS 7.5' series Greencastle, Indiana quadrangle.

Investigation Area 12

Investigation area 12 is located in Wayne County (Gaw 1992). The original survey showed the potential for intact buried deposits. The soil within the project area is Genesee silt loam. A total of four bucket auger were utilized to confirm the presence of well drained alluvium prior to the subsurface reconnaissance (Stillwell 1992c). The subsurface reconnaissance was conducted near the stream channel. A total of two trenches were excavated. The trenches within the project area revealed a high water table and some gravel in a trench at depths of only 60 cm. No profiles of trenches were in the report. The descriptions of the profiles indicate a 10YR3/2 to a depth of 18 cm with a silty clay texture and a weak subangular blocky, friable structure. The B-horizon was from 18 cm and was a 10YR3/3 silty clay with a weak subangular blocky, friable structure to 48 cm. Beneath the B-horizon was a zone of clay and gravel. The width of the stream valley at the location of the project area is 1400 m (Figure 21).

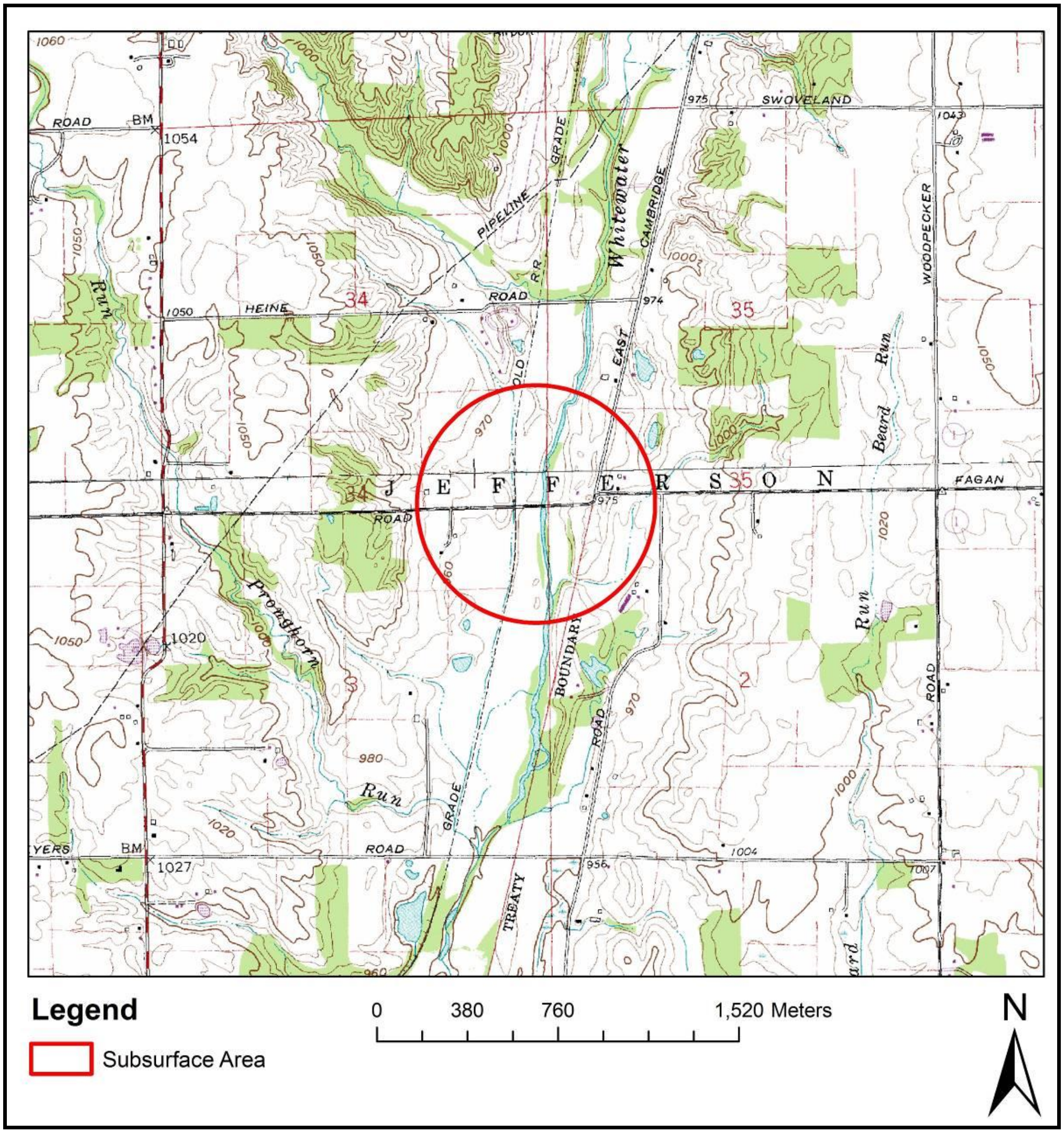


Figure 30. Subsurface Area 12 as shown on the USGS 7.5' series Cambridge City and Hagerstown, Indiana quadrangles.

Investigation Area 13

Investigation area 13 is located in Henry County (Zoll 1994b). The original survey showed the potential for intact buried deposits. The soil within the project area is Shoals silt loam. Bucket augers confirmed the presence of alluvium and a subsurface investigation was recommended. At the time of the planned subsurface it was discovered that the project area had shifted. It was determined in the field that the new area would likely require subsurface investigation as well and subsurface investigation was undertaken. The subsurface reconnaissance was conducted right beside the current stream channel. A total of two trenches were excavated. The trenches within the project area revealed poorly drained soils with high energy deposits. A trench profile showing the sediments discovered is included below (Figure 22). The width of the stream valley at the location of the project area is 800 m (Figure 23).

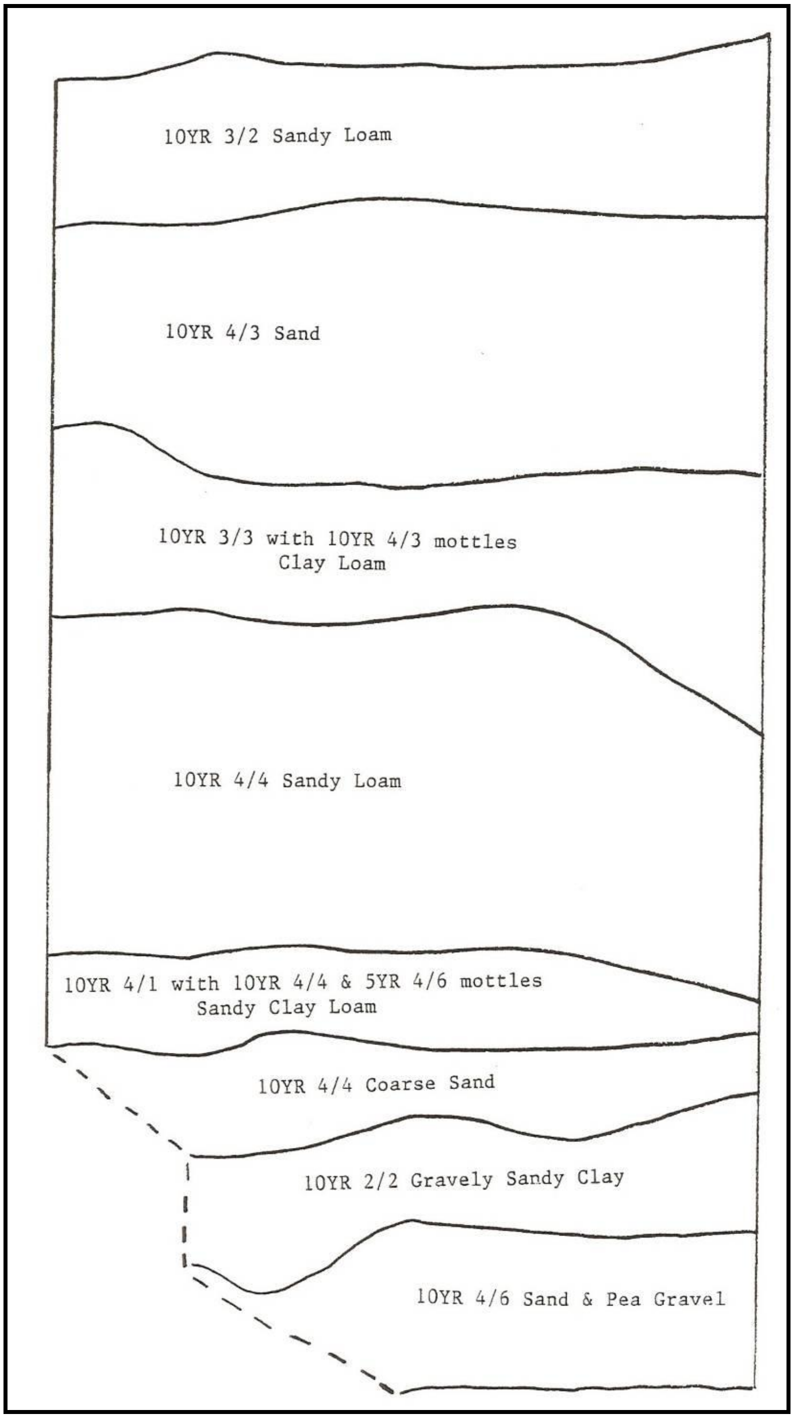


Figure 31. Profile of typical trench in Subsurface Area 13 (Zoll 1994b).

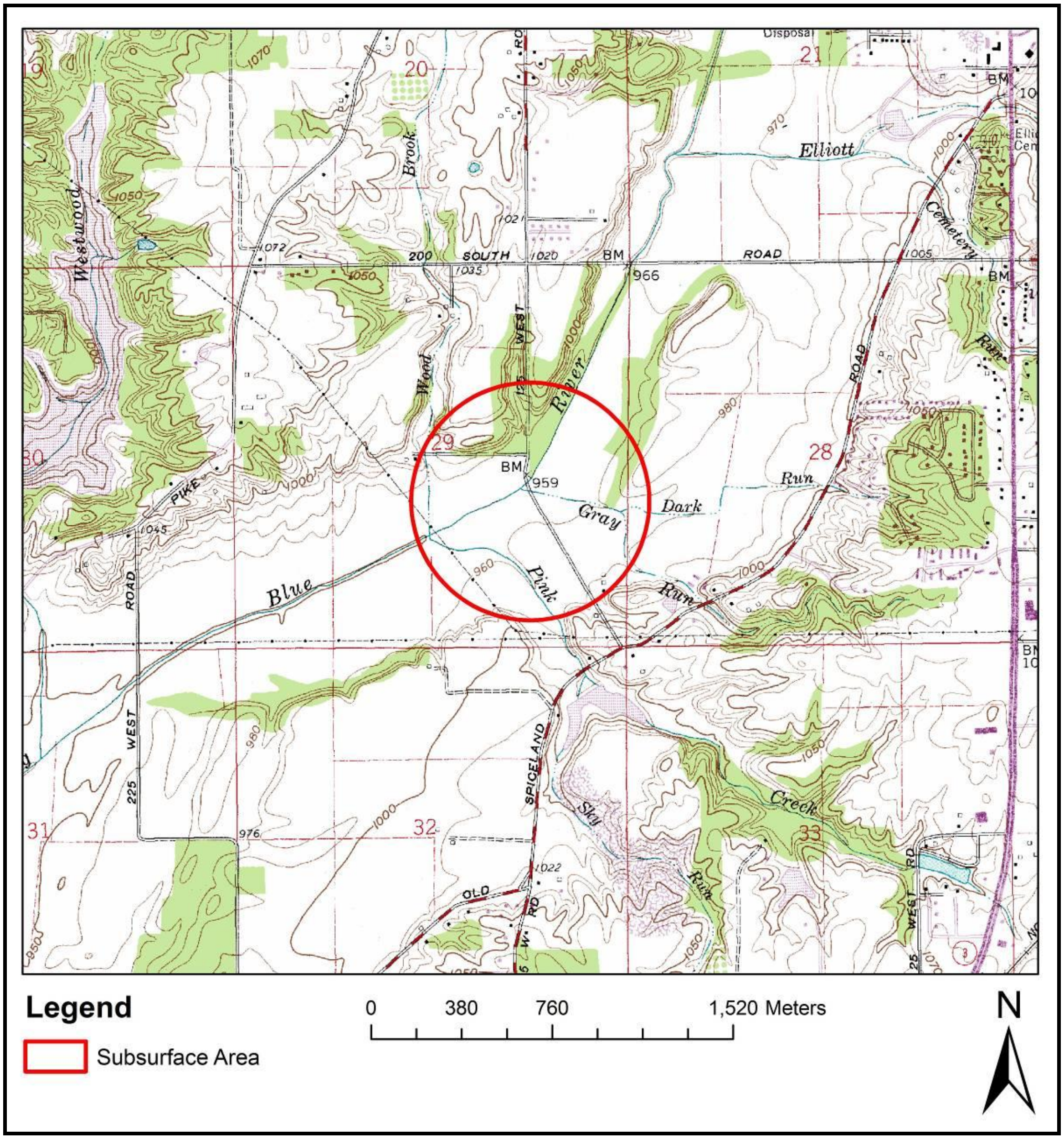


Figure 32. Subsurface Area 13 as shown on the USGS 7.5’ series New Castle, Indiana quadrangle.

Investigation Area 14

Investigation area 14 is located in Madison County (Zoll 1999b). The original survey showed the potential for intact buried deposits. The soil within the project area is Genesee silt loam. It is unknown whether the recommendation for subsurface investigation was made based on the results of bucket augers or simply on county soil maps. The subsurface reconnaissance was conducted along a portion of moderately entrenched valley. Two trenches were excavated within the project area. The trenches revealed active deposition and scouring with multiple thin lenses and layers of sand and sandy loam. A trench profile showing the sediments discovered is included below (Figure 24). The width of the stream valley at the location of the project area is 840 m (Figure 25).

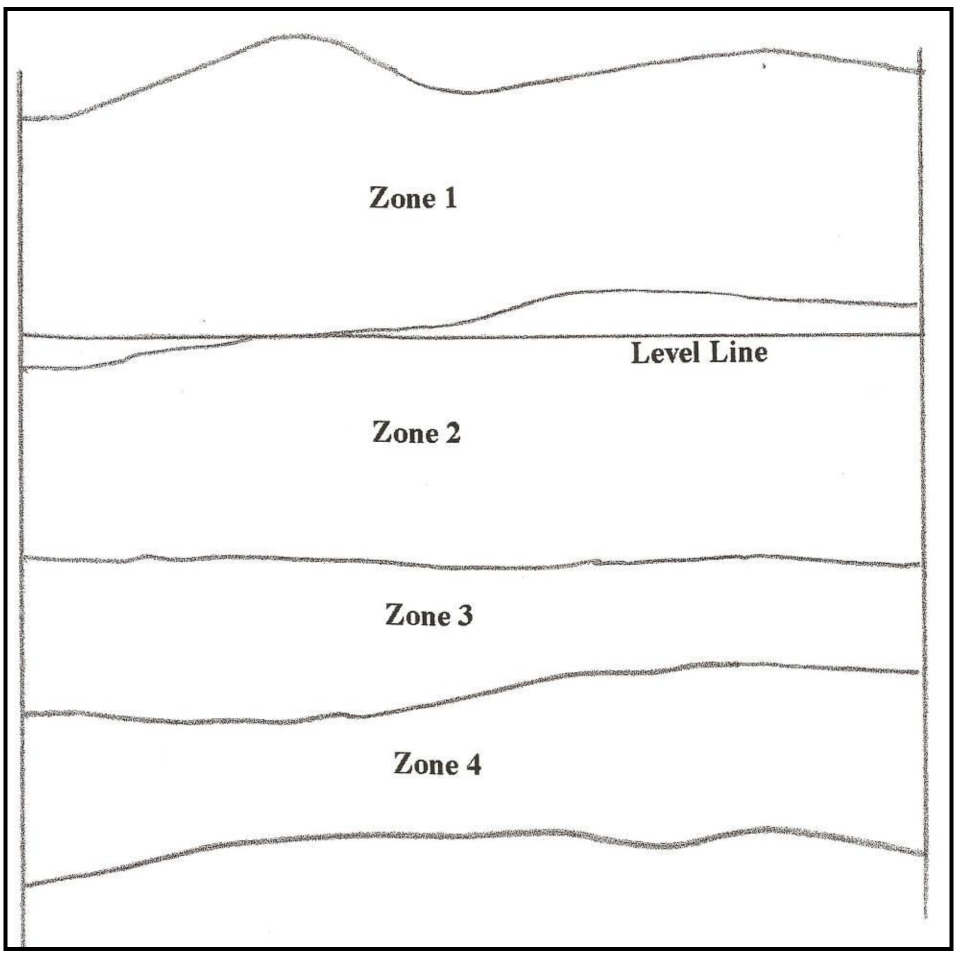


Figure 33. Profile of typical trench in Subsurface Area 14 (Zoll 1999b). Zone 1 was a 10YR3/2 silt loam, Zone 2 was a 10YR3/2 loam, Zone 3 was a 10YR4/3 loamy sand, Zone 4 was a 10YR5/4 sand.

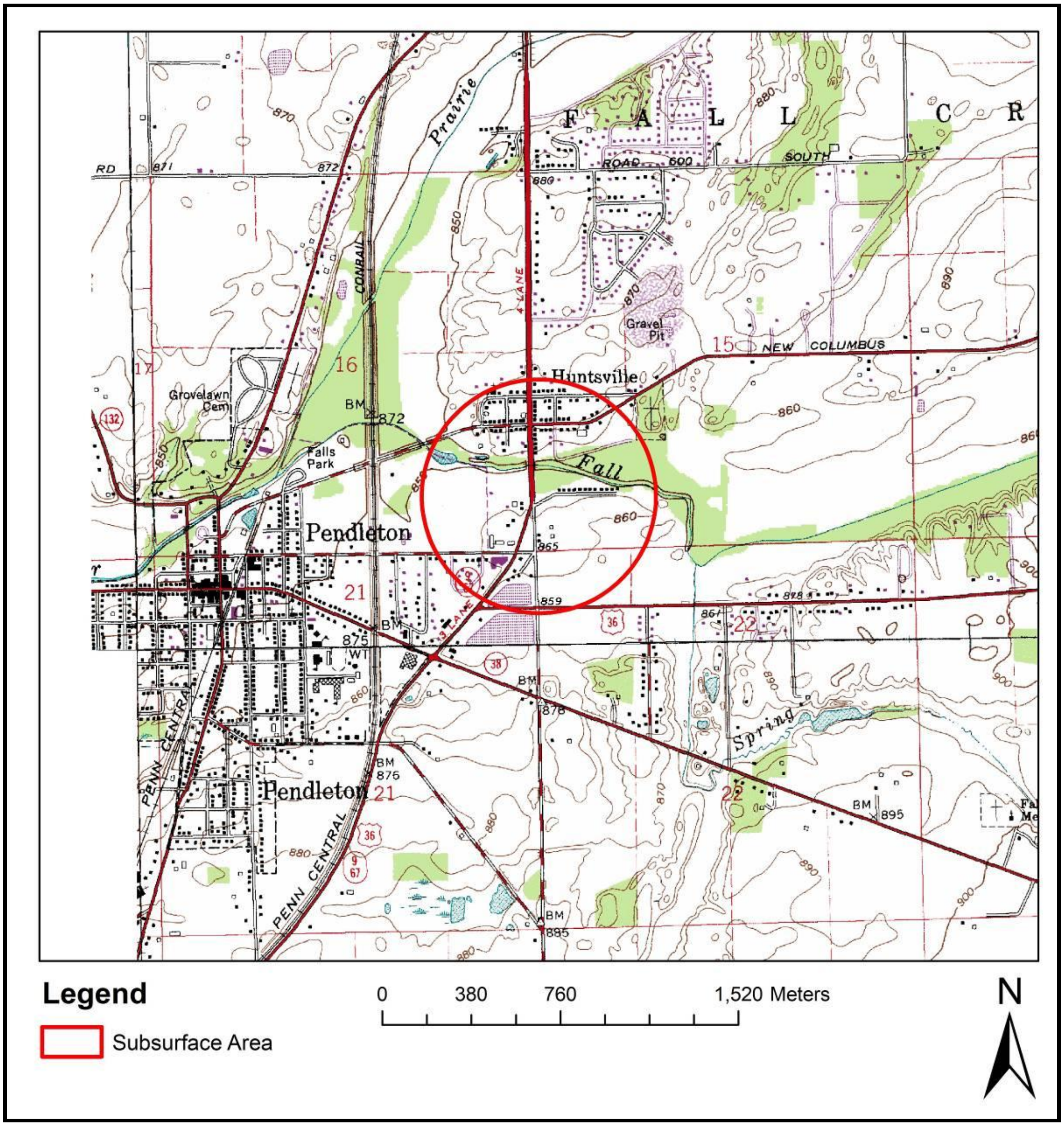


Figure 34. Subsurface Area 14 as shown on the USGS 7.5' series Anderson South and Pendelton quadrangles.

Investigation Area 15

Investigation area 15 is located in Madison County (Zoll 1989). The original survey showed the potential for intact buried deposits based upon the general soils maps. The soil within the project area is Genesee silt loam. It is unknown whether bucket augers were utilized to verify the presence of well drained alluvium (Zoll 1989). The subsurface reconnaissance was conducted at the edge of the floodplain and the outwash terrace. A total of nine trenches were excavated within the project area. The trenches within the project area revealed silt loams. No profiles of the trenches were in the report. Artifacts were recovered from one of the trenches at a depth of 45 cm below ground surface. The artifacts were limited to flakes and fire cracked rock. No diagnostic artifacts were recovered and no features were encountered. The subsurface site was not considered eligible for listing on the State or National Registers. The width of the stream valley at the location of the project area is 610 m (Figure 26).

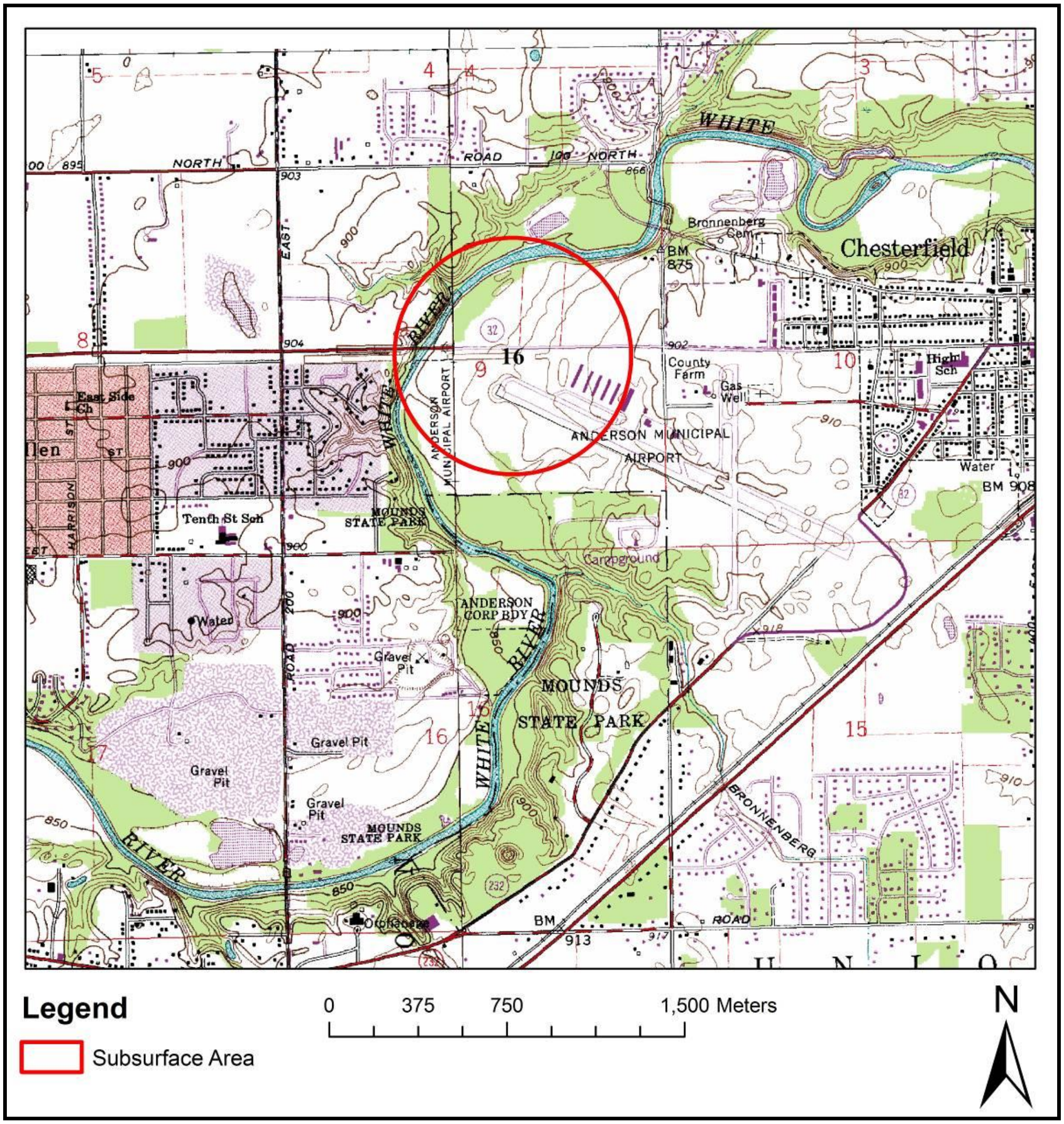


Figure 35. Subsurface Area 15 as shown on the USGS 7.5' series Bippus, Indiana quadrangle.

Investigation Area 16

Investigation area 16 is located in Hamilton County (McCord 1996). The original survey showed the potential for intact buried deposits. The soils within the project area are Genesee and Ross silt loams. The subsurface reconnaissance was conducted across the broad floodplain. The trenches within the project area revealed soils that varied between poorly drained and well drained as well as high energy and low energy alluvium. The valley setting was determined to be highly variable and largely unpredictable from the surface. Additionally, coring at the site did little to elucidate the deposition at the site (Cantin et al. 2003). Intact buried deposits were located within the project area and were determined to be eligible for listing on the State and National Registers. The width of the stream valley at the location of the project area is approximately 2.2 km (Figure 27).

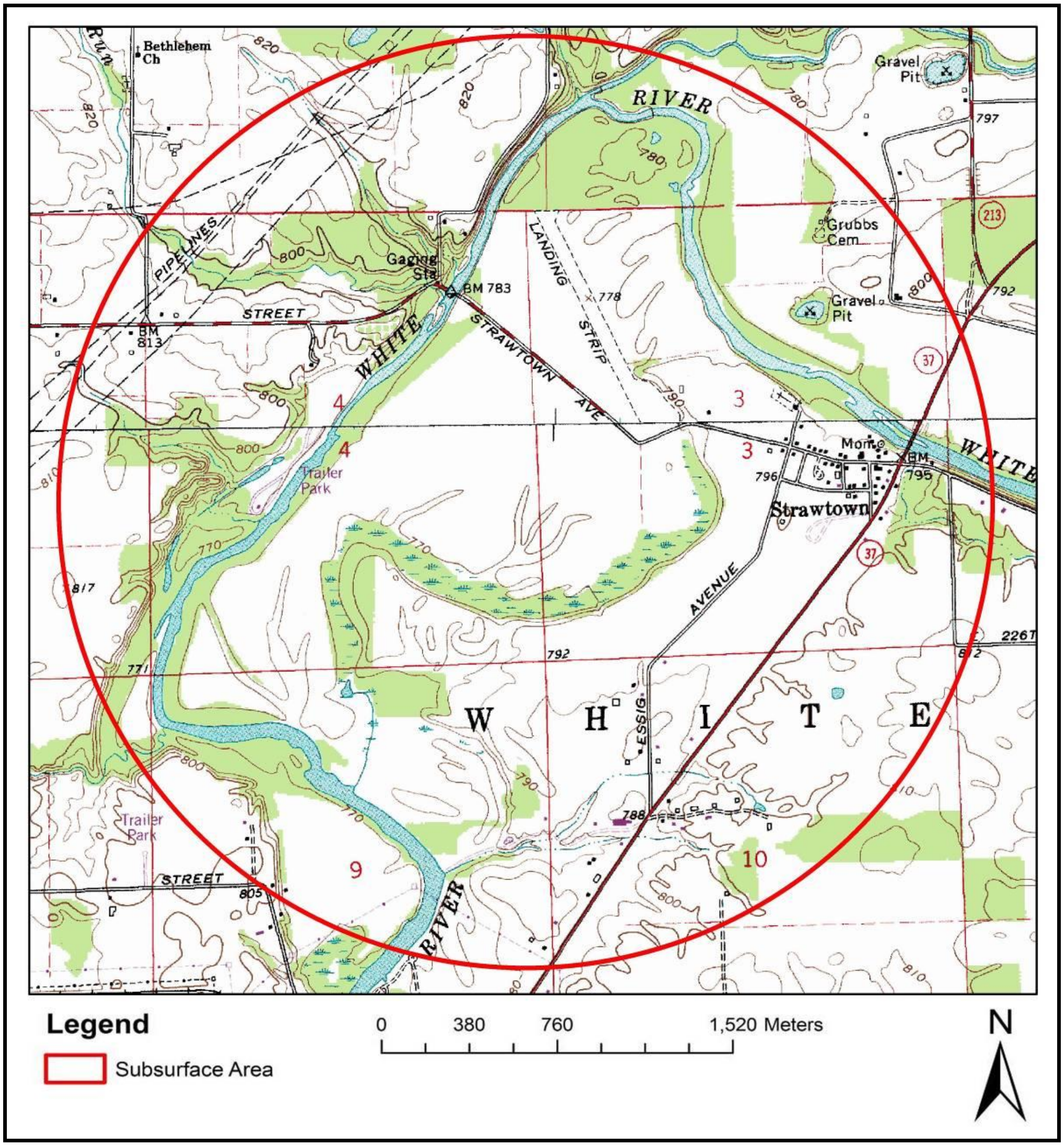


Figure 36. Subsurface Area 16 as shown on the USGS 7.5' series Omega and Riverwood, Indiana quadrangles.

Investigation Area 17

Investigation area 17 is located in Hamilton County (Zoll 1997). The original survey showed the potential for intact buried deposits. The soils within the project area are Genesee silt loam. An unknown number of bucket augers were utilized to confirm the presence of well drained alluvium and a subsurface investigation was recommended. The subsurface reconnaissance was conducted immediately beside the river channel. A total of eight trenches were excavated. The trenches within the project area revealed high energy deposits. A trench profile showing the sediments discovered is included below (Figure 28). The width of the White River valley at the location of the project area is 2290 m (Figure 29).

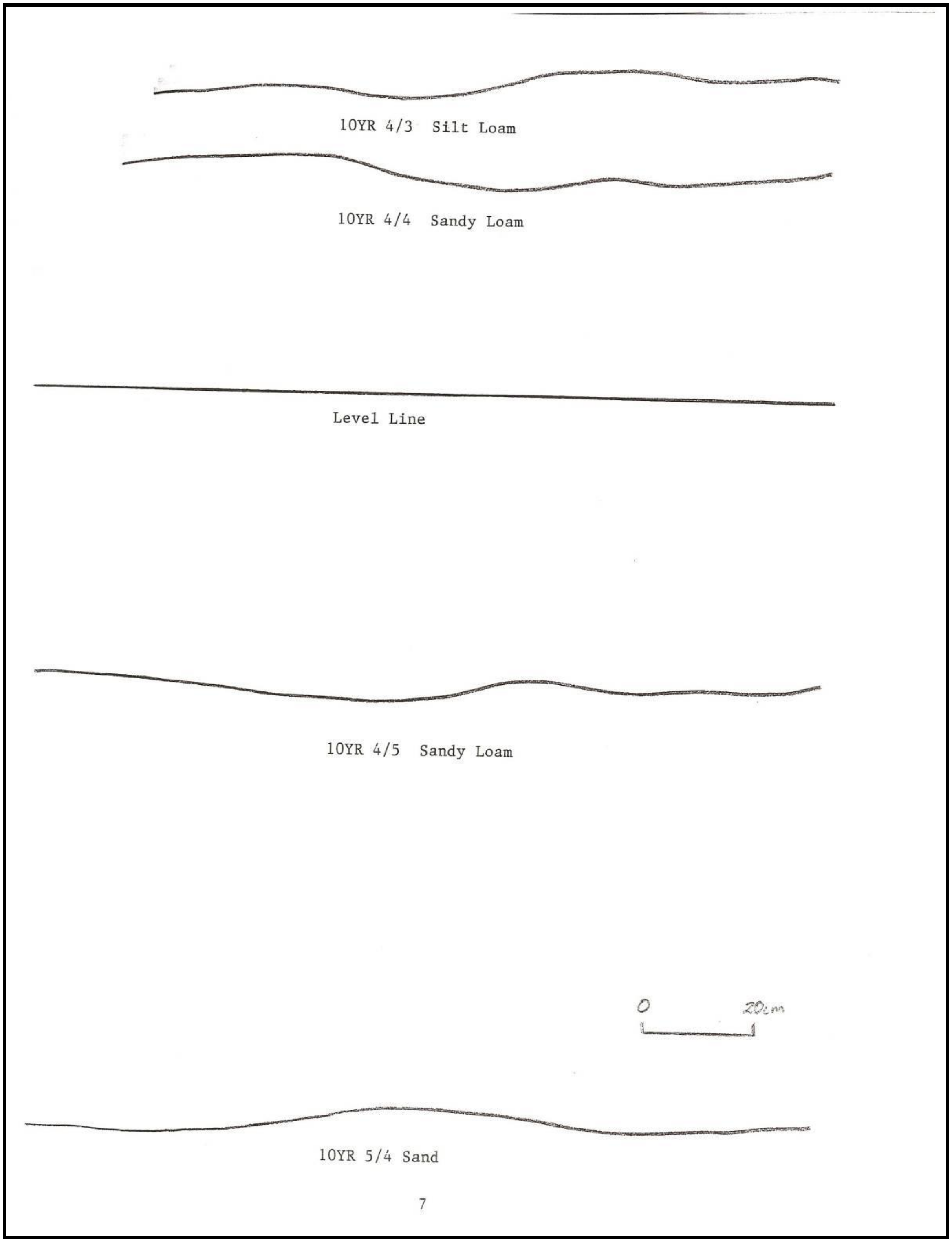


Figure 37. Profile of typical trench in Subsurface Area 17 (Zoll 1997).

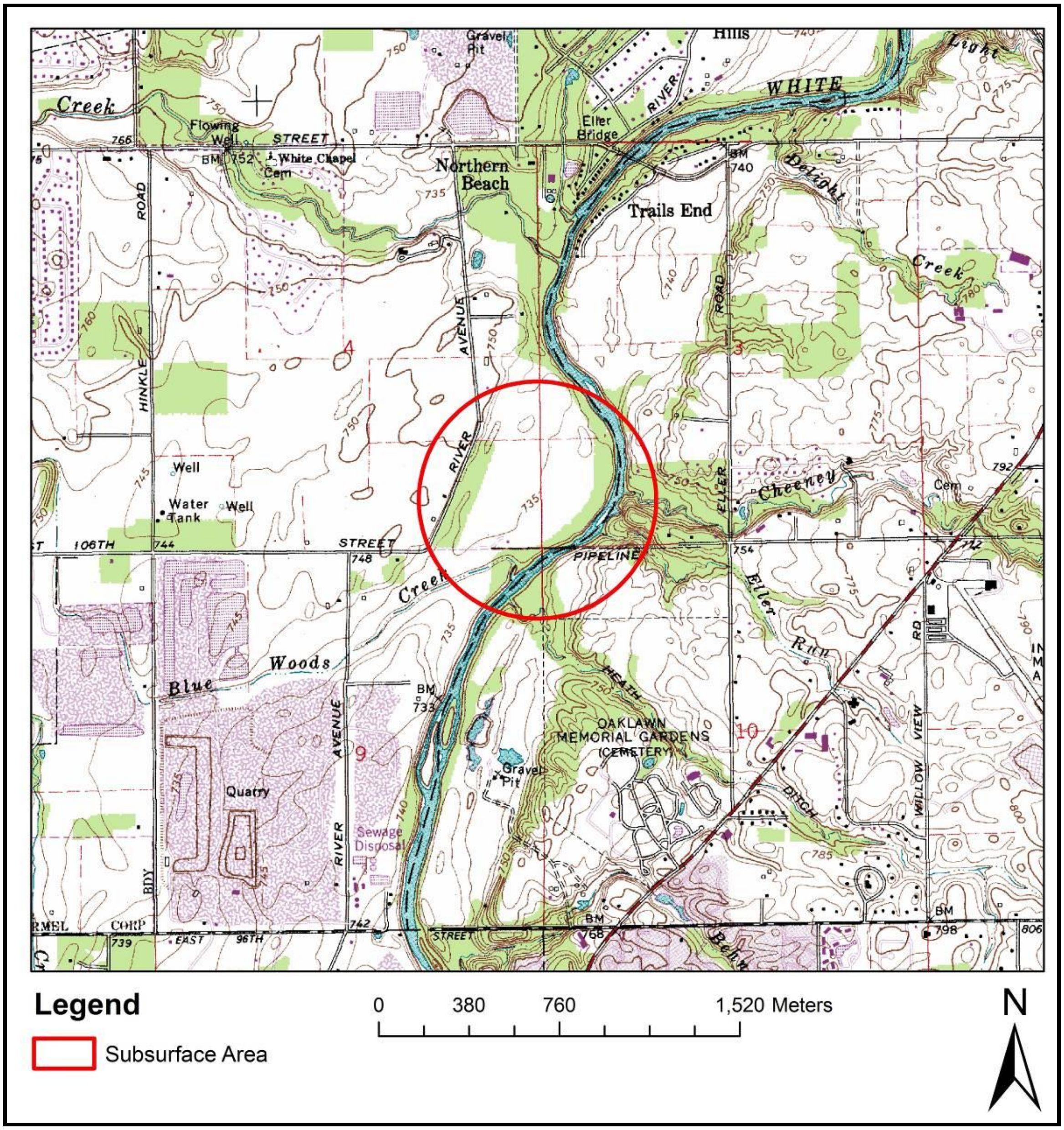


Figure 38. Subsurface Area 17 as shown on the USGS 7.5' series Fishers, Indiana quadrangle.

Investigation Area 18

Investigation area 18 is located in Hamilton County (McCord 2002a). The original survey showed the potential for intact buried deposits. The soil within the project area is Genesee silt loam. During the original survey eight bucket augers were utilized to determine the potential for buried archaeological deposits (Cox 2001). The subsurface reconnaissance was conducted on the downstream end of a point bar. A total of five trenches were excavated within the project area. The trenches contained soils varying from clay loams to sandy loams that indicated a dynamic floodplain setting. The trenches within the project area revealed a highly variable depositional pattern for this portion of the floodplain. A trench profile showing the sediments discovered is included below (Figure 30). The width of the river valley at the location of the project area is approximately 2200 m (Figure 31).

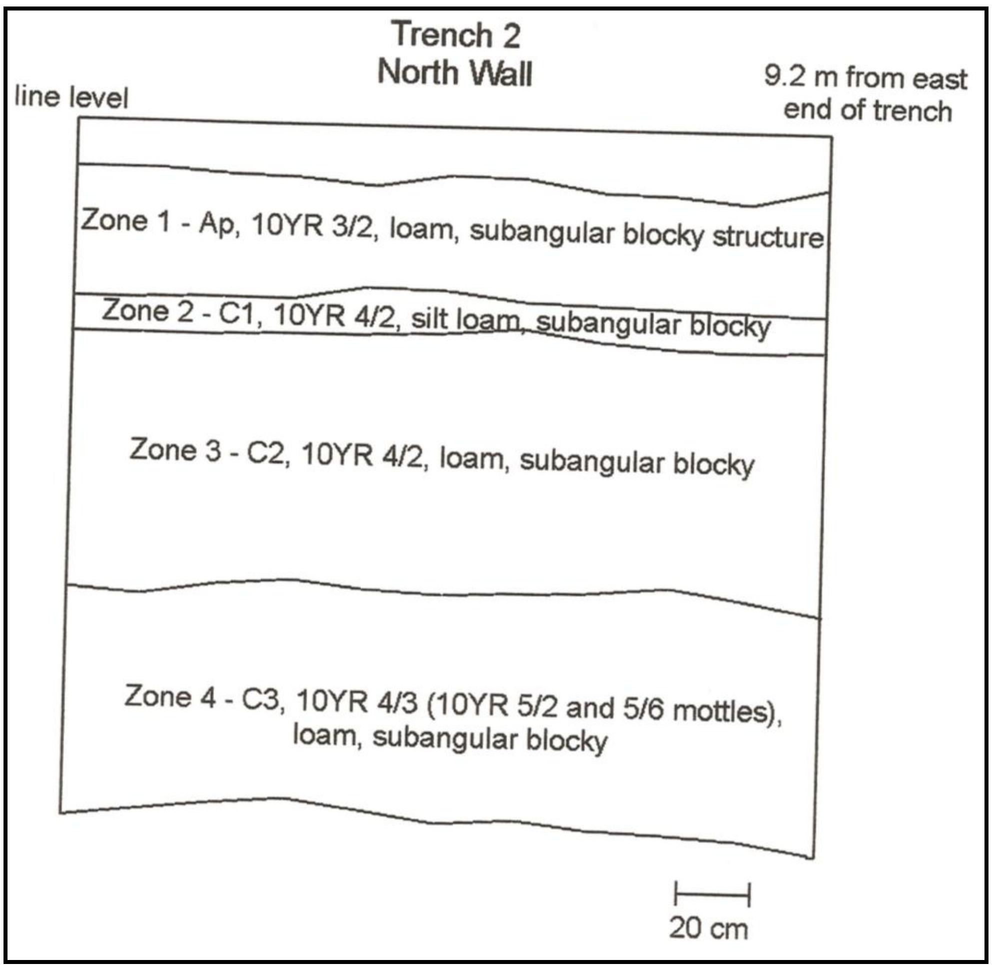


Figure 39. Profile of a trench in Subsurface Area 18 (McCord 2002a).

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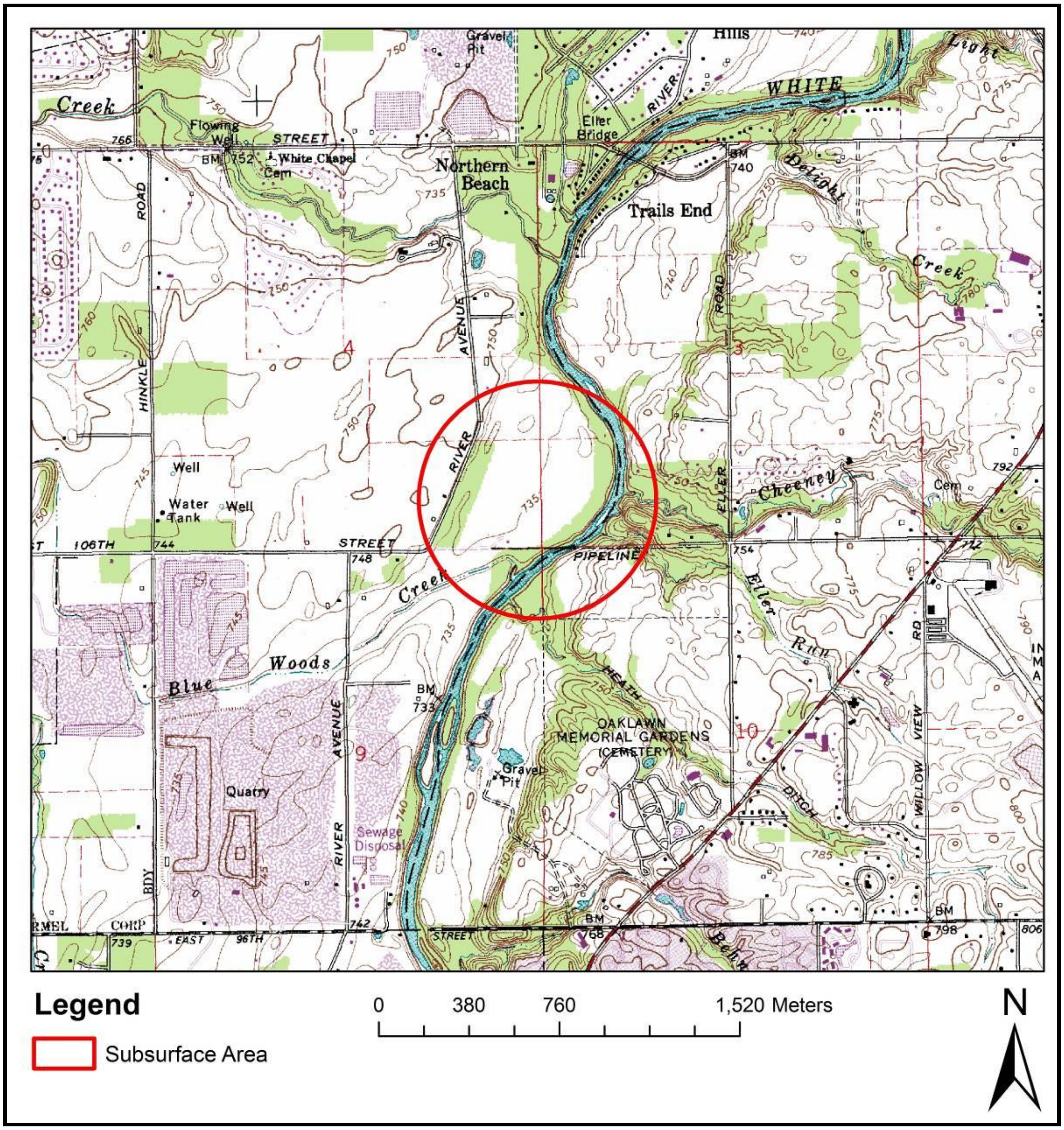

Figure 40. Subsurface Area 18 as shown on the USGS 7.5’ series Fishers, Indiana quadrangle.

Investigation Area 19

Investigation area 19 is located in Hamilton County (McCord 2002b). The original survey showed low potential for intact buried deposits. The soils within the project area are Shoals silt loams. A total of two bucket auger cores were excavated within the project area and demonstrated the presence of poorly drained alluvium (Stillwell 2001a). Only at the insistence of the Indiana Department of Natural Resources, Divisions of Water and Historic Preservation and Archaeology was a subsurface investigation undertaken. Shoals silt loams are typically poorly drained, being lower in topography than the co-occurant Genesee, Eel and Ross soils. A total of four trenches were excavated within the project area. The trenches within the project area revealed poorly drained soils. A trench profile showing the sediments discovered is included below (Figure 32). The width of the stream valley at the location of the project area is 2200 m (Figure 33).

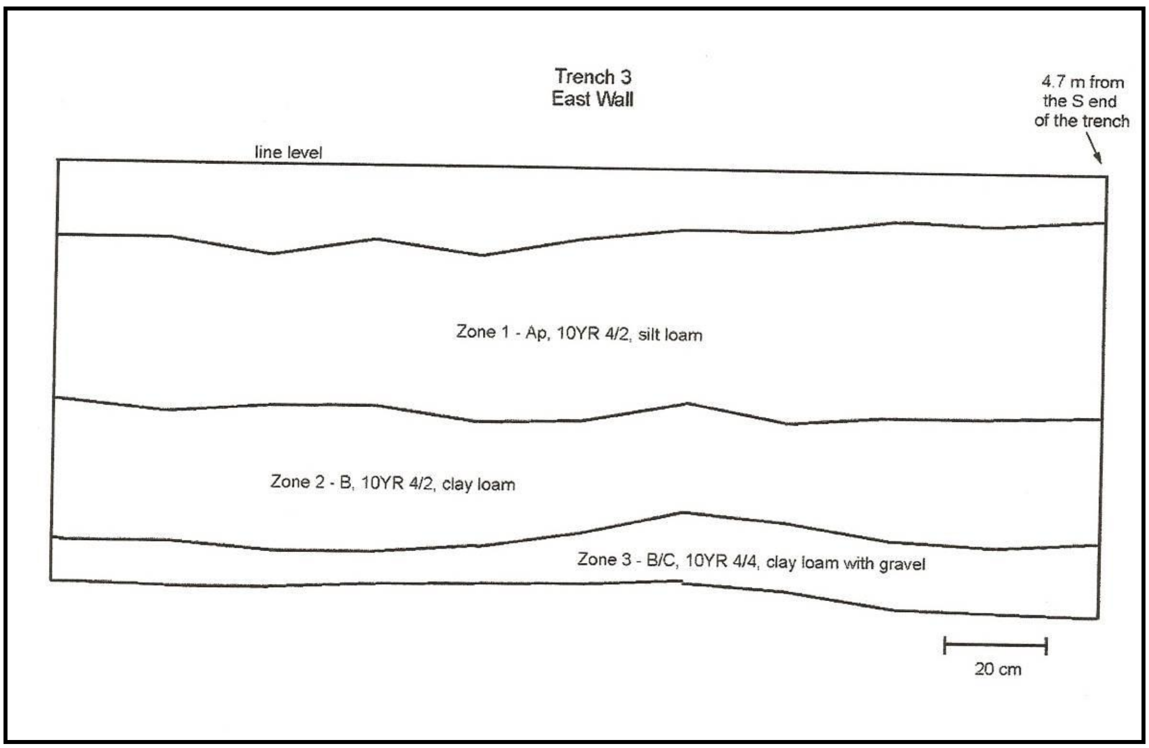

Figure 41. Profile of typical trench in Subsurface Area 19 (McCord 2002b).

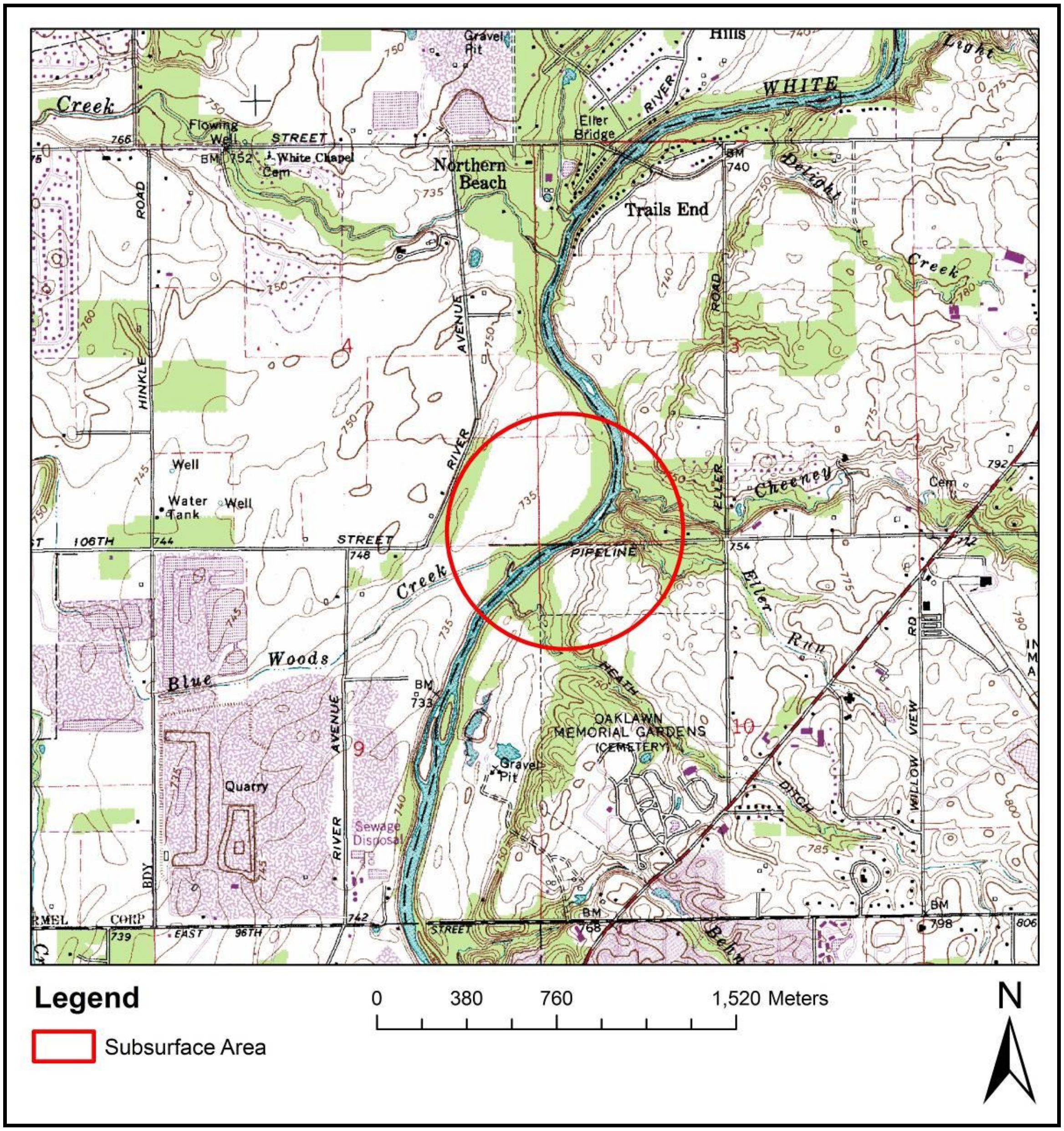

Figure 42. Subsurface Area 19 as shown on the USGS 7.5’ series Fishers, Indiana quadrangle.

Investigation Area 20

Investigation area 20 is located in Marion County (Buechler 1993). The original survey showed the potential for intact buried deposits. The soil within the project area is Genesee silt loam. An unknown number of bucket augers were utilized to confirm the presence of well drained alluvium and a subsurface investigation was undertaken. The subsurface reconnaissance was conducted near the stream channel. A total of two trenches were excavated. The trenches within the project area revealed high energy deposits with some indication of poorly drained characteristics. A trench profile showing the sediments discovered is included below (Figure 34). The width of the Fall Creek valley at the location of the project area is 450 m (Figure 35).

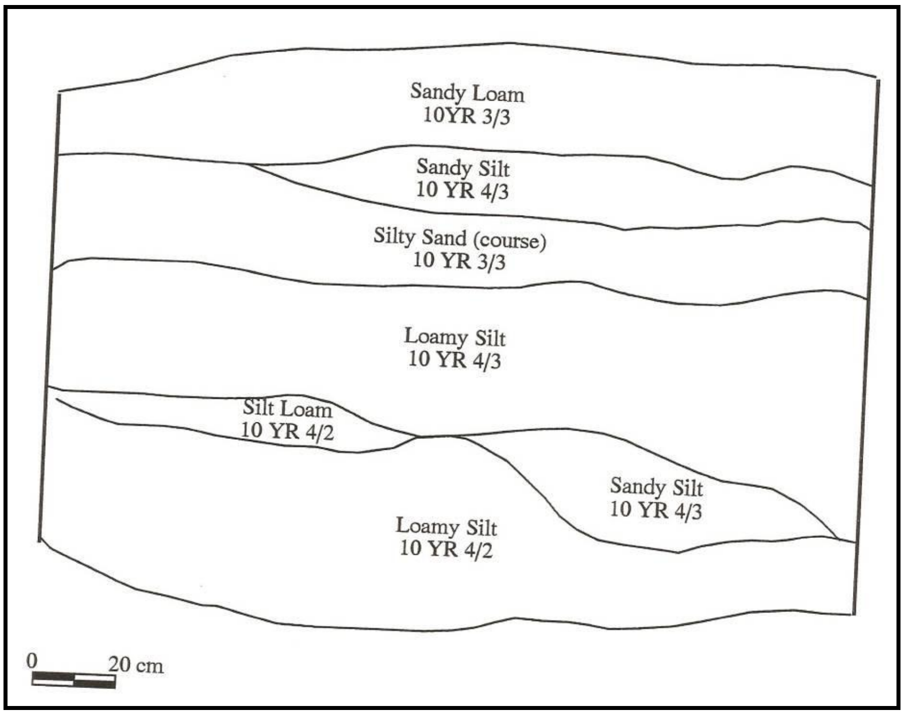

Figure 43. Profile of typical trench in Subsurface Area 20 (Buechler 1993).

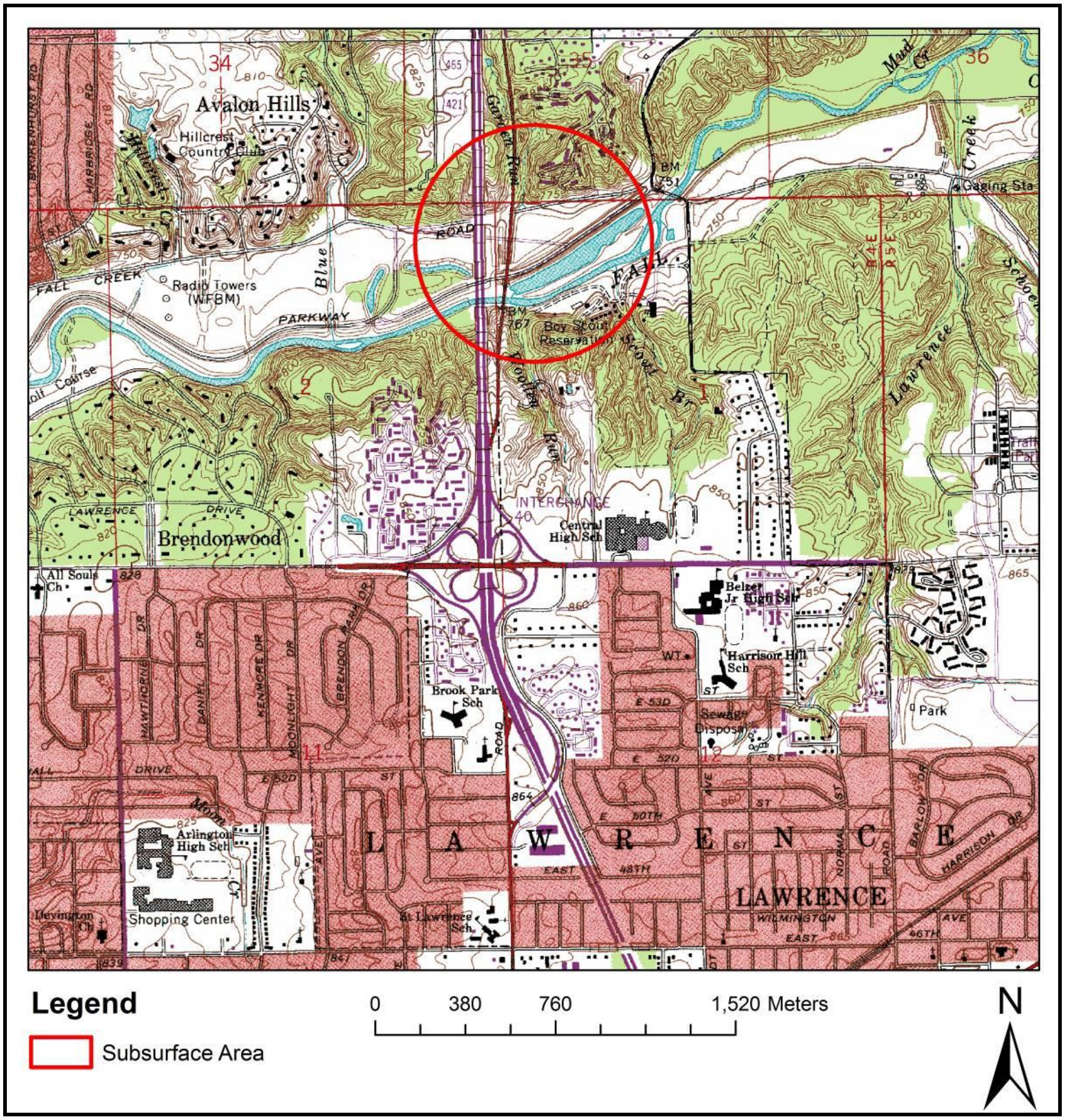

Figure 44. Subsurface Area 20 as shown on the USGS 7.5' series Indianapolis East, Indiana.

Investigation Area 21

Investigation area 21 is located in Rush County (Zoll 2000). The original survey showed the potential for intact buried deposits. The soils within the project area are Genesee silt loam and Sloan silt loam. Bucket augers confirmed the presence of well drained alluvium and a subsurface investigation was undertaken although it was unspecified how many were conducted. The subsurface reconnaissance was conducted at an area where two small order streams meet. A total of six trenches were excavated within the project area. The trenches within the project area revealed soils of varying depositional energies. A trench profile showing the sediments discovered is included below (Figure 36). The width of the stream valley at the location of the project area is 430 m (Figure 37).

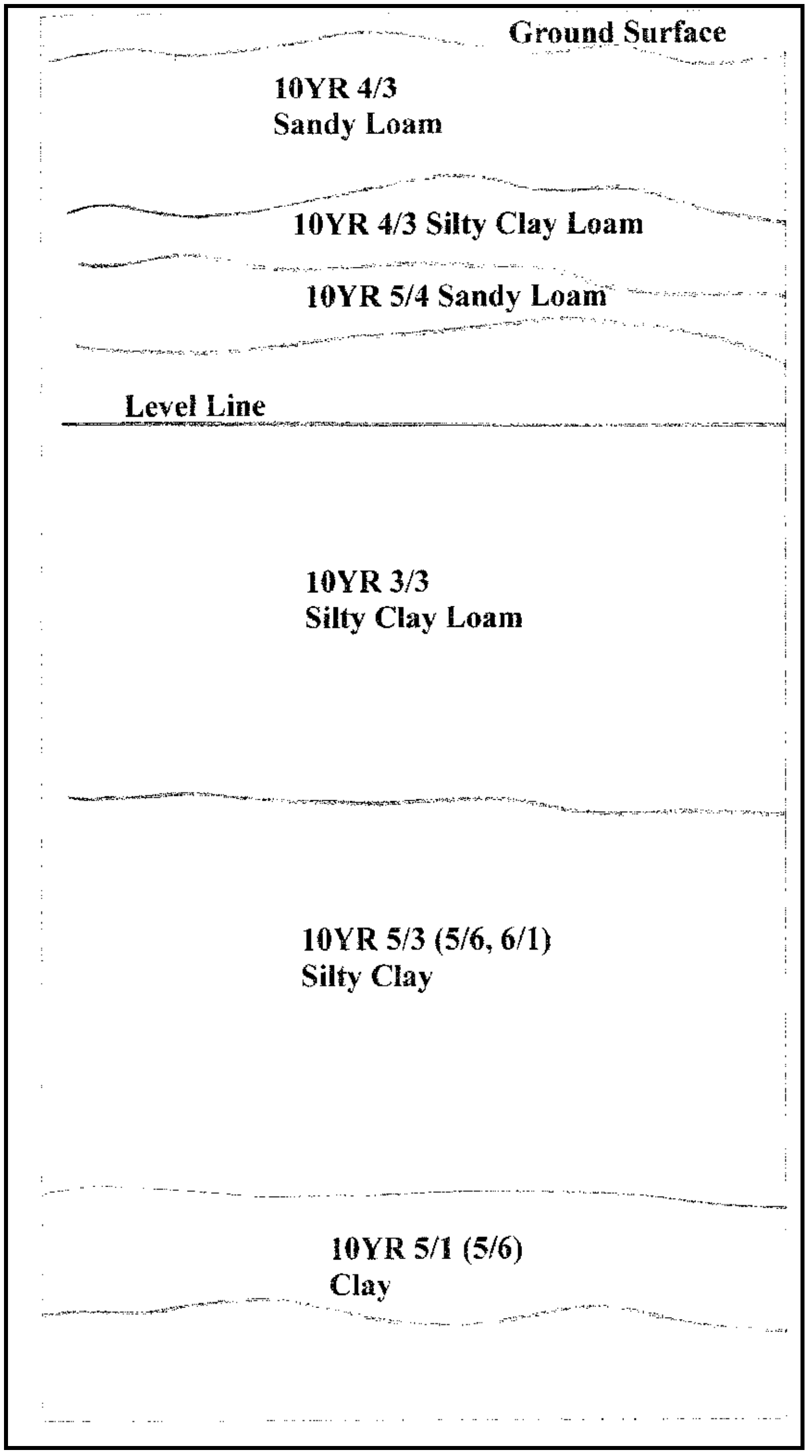

Figure 45. Profile of typical trench in Subsurface Area 21 (Zoll 2000).

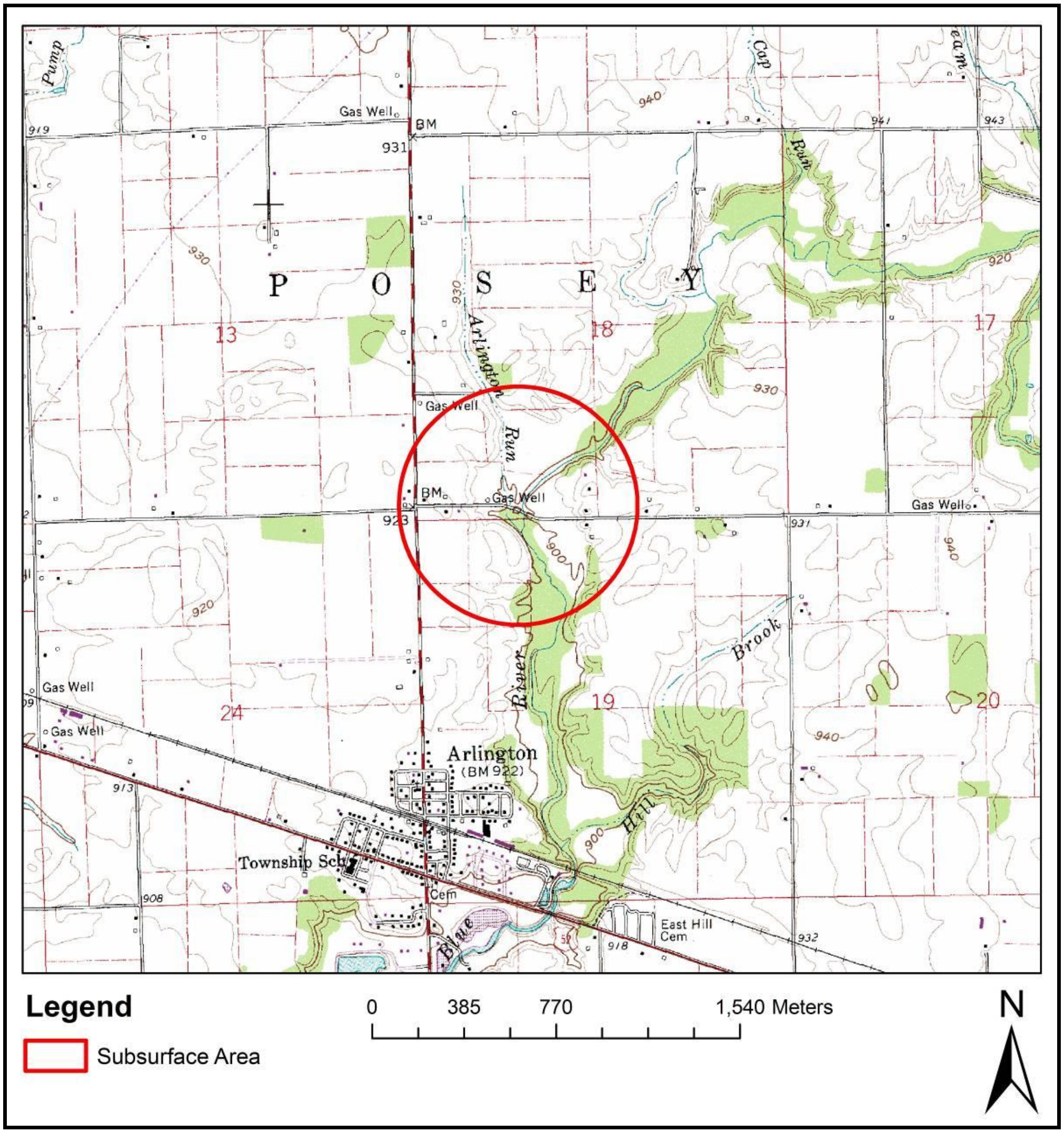

Figure 46. Subsurface Area 21 as shown on the USGS 7.5' series Carthage, Indiana quadrangle.

Investigation Area 22

Investigation area 22 is located in Rush County (Zoll 1995). The original survey showed the potential for intact buried deposits. The soil within the project area is Shoals silt loam. A total of two bucket augers were utilized to confirm the presence of alluvium and a subsurface investigation was undertaken. The subsurface reconnaissance was conducted within the lower valley. A total of two trenches were excavated. The trenches within the project area revealed poorly drained, high energy deposits. No trench profiles were drawn. The width of the stream valley at the location of the project area is 180 m (Figure 38).

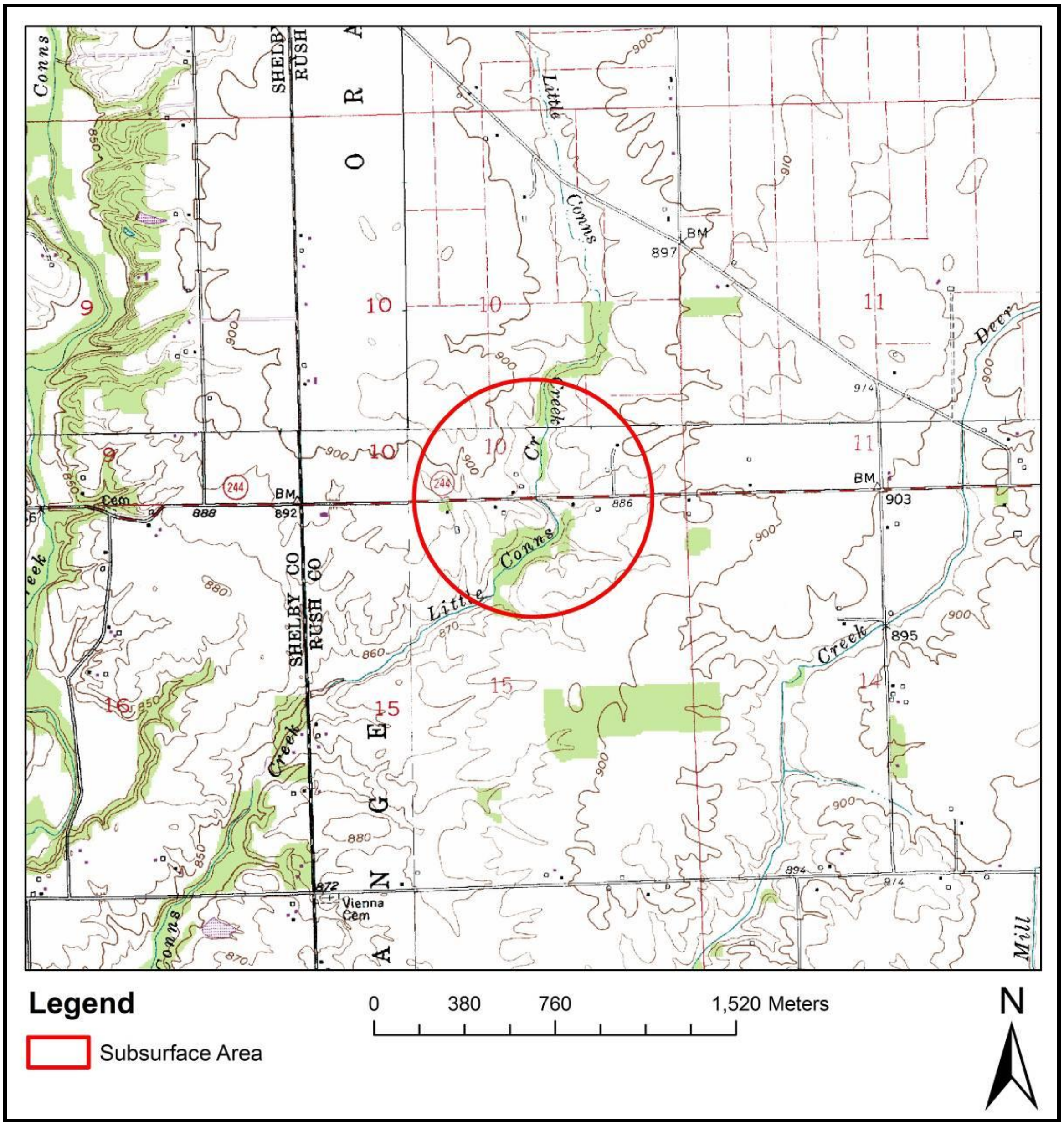

Figure 47. Subsurface Area 22 as shown on the USGS 7.5' series Adams, Manilla, Rays Crossing and Waldron quadrangles.

Investigation Area 23

Investigation area 23 is located in Decatur County (Zoll 2002). The original survey showed the potential for intact buried deposits. The soils within the project area are Fox loam and Chagrin loam; outwash and floodplain soils respectively. If bucket augers had been utilized, they would have revealed the sand and gravel later revealed by the trenching. A total of five trenches were excavated within the project area, many of which were too unstable to clean. These unstable sandy, gravely soils are not conducive to intact site burial. The subsurface reconnaissance was conducted right along the river near the middle of the valley. A trench profile showing the sediments discovered is included below (Figure 39). The width of the stream valley at the location of the project area is 650 m (Figure 40).

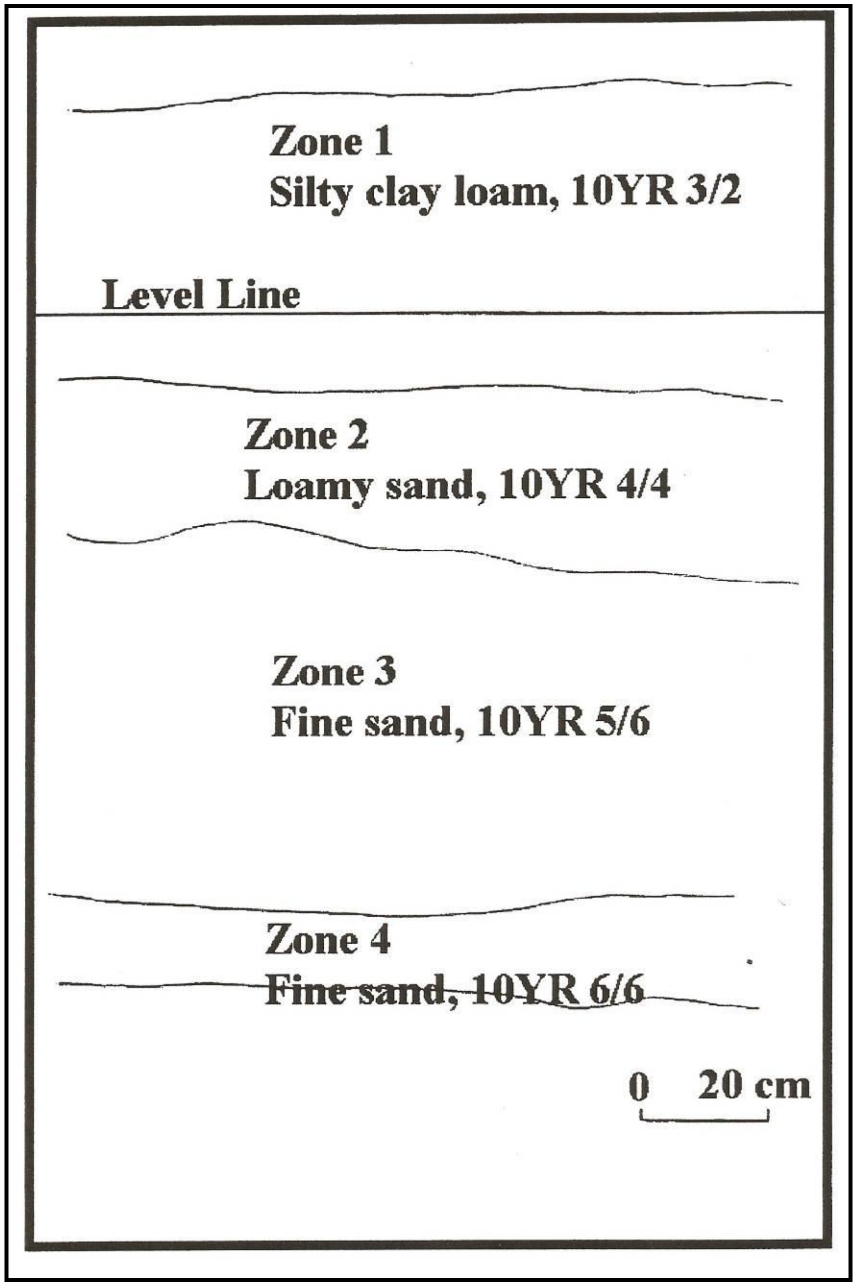

Figure 48. Profile of typical trench in Subsurface Area 23 (Zoll 2002).

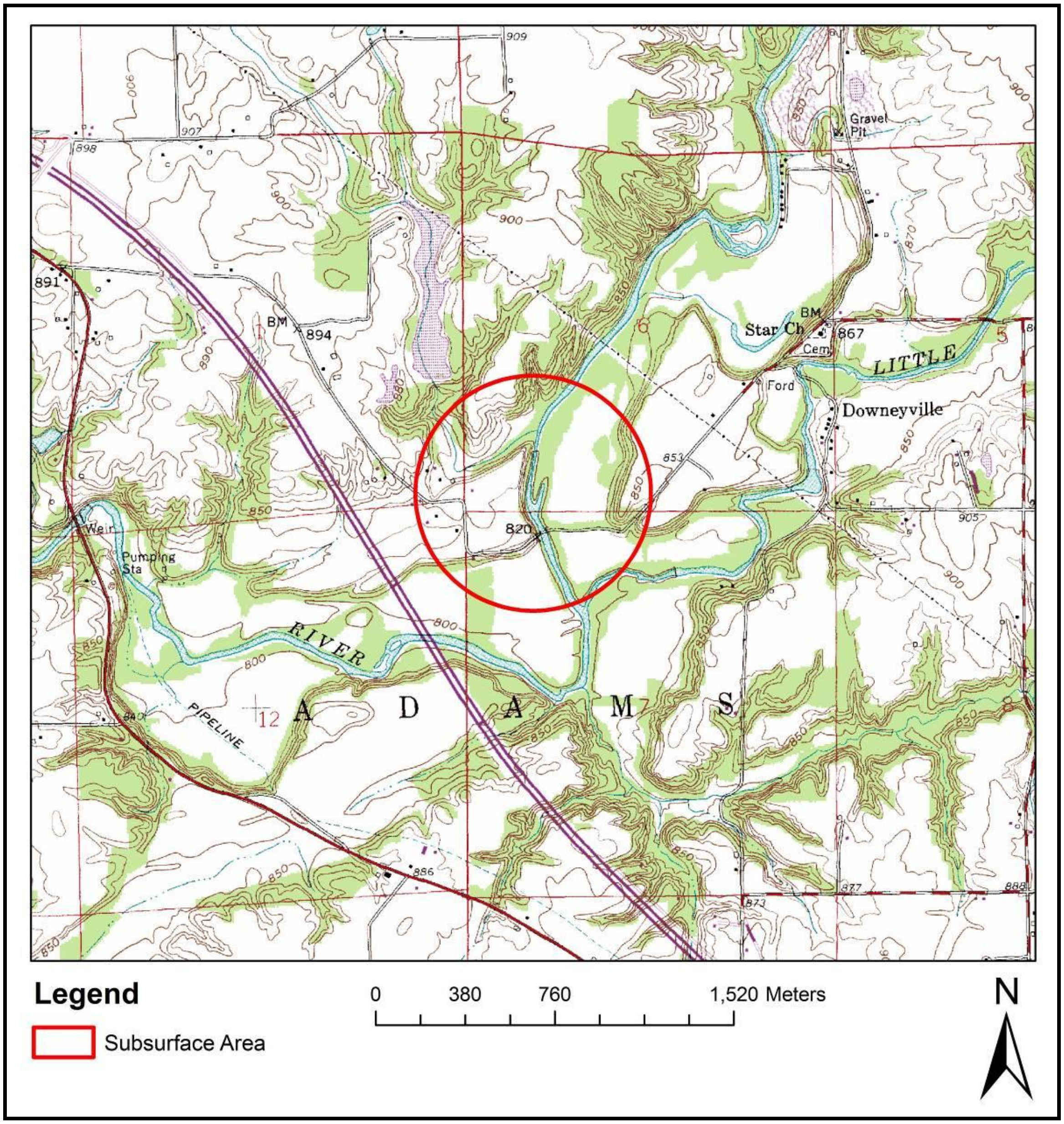

Figure 49. Subsurface Area 23 as shown on the USGS 7.5' series Adams, Indiana quadrangle.

Investigation Area 24

Investigation area 24 is located in Fayette County (Waldron 1995). The original survey showed the potential for intact buried deposits. The soil within the project area is Eel silt loam. An unknown number of bucket augers were utilized to confirm the presence of well drained low energy alluvium and a subsurface investigation was recommended. The subsurface reconnaissance was conducted near the creek banks. The trenches within the project area revealed very high energy deposits including what appeared to be an old channel. A trench profile showing the sediments discovered is included below (Figure 41). The width of the stream valley at the location of the project area is 230 m (Figure 42).

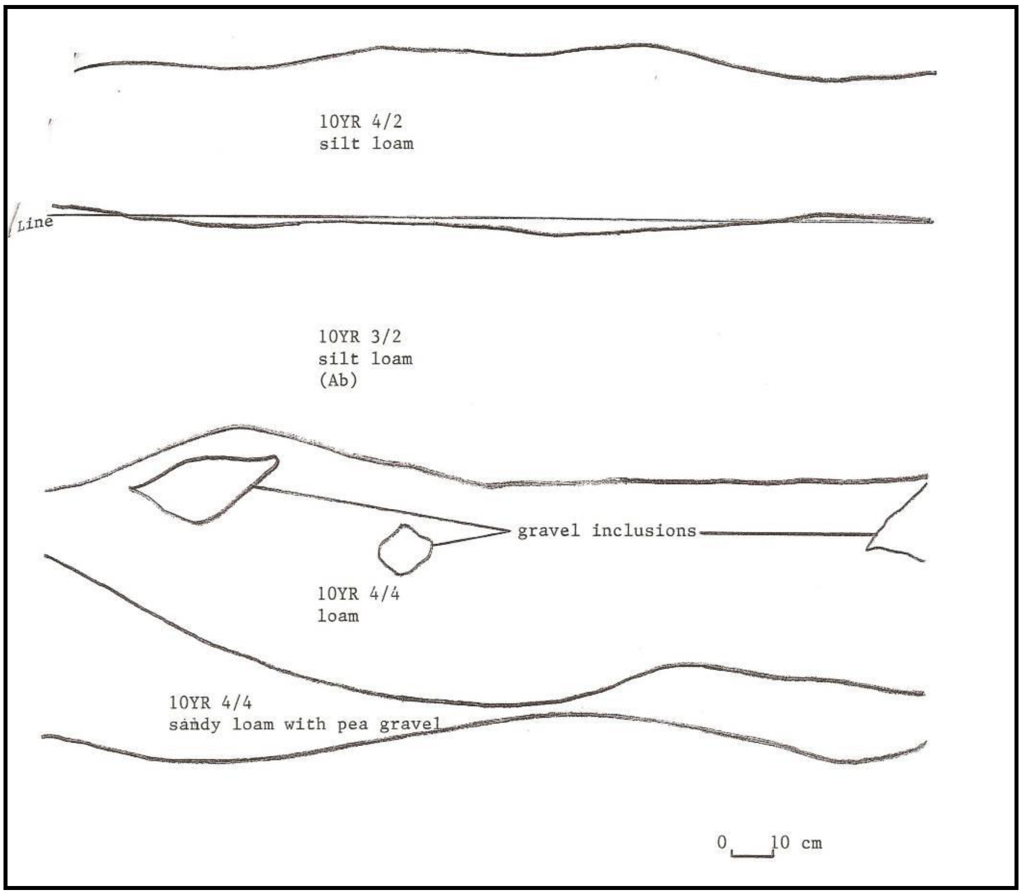

Figure 50. Profile of typical trench in Subsurface Area 24 (Waldron 1995).

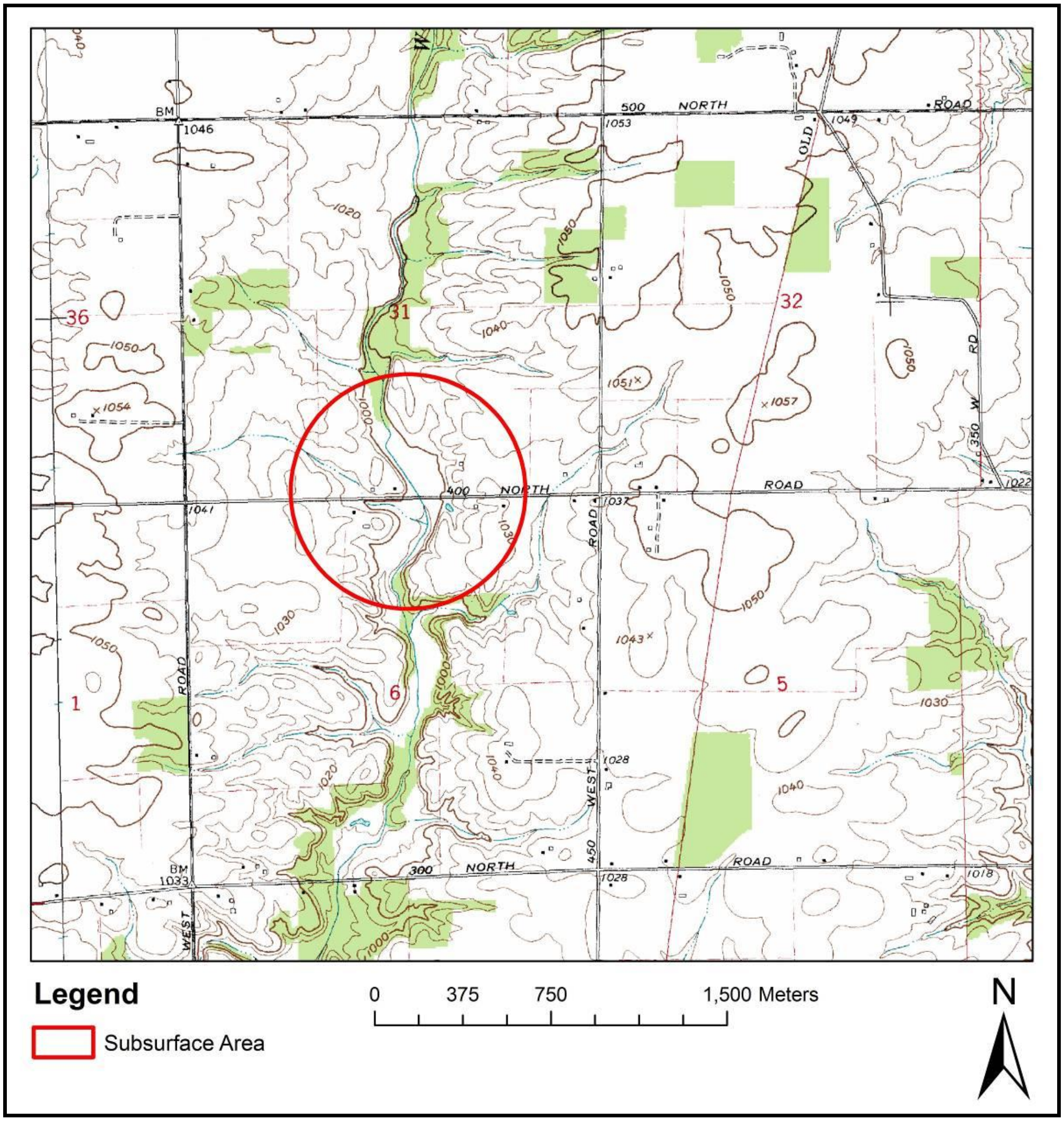

Figure 51. Subsurface Area 24 as shown on the USGS 7.5' series Connersville, Indiana quadrangle.

Investigation Area 25

Investigation area 25 is located in Fayette County (Zoll 1993). The original survey showed the potential for intact buried deposits. The soils within the project area are Genesee silt loam. An unknown number of bucket augers were utilized to confirm the presence of low energy alluvium. The subsurface reconnaissance was conducted adjacent to the stream channel. A total of four trenches were excavated. The trenches within the project area revealed poorly drained high energy alluvium. A trench profile showing the sediments discovered is included below (Figure 43). The width of the stream valley at the location of the project area is 250 m (Figure 44).

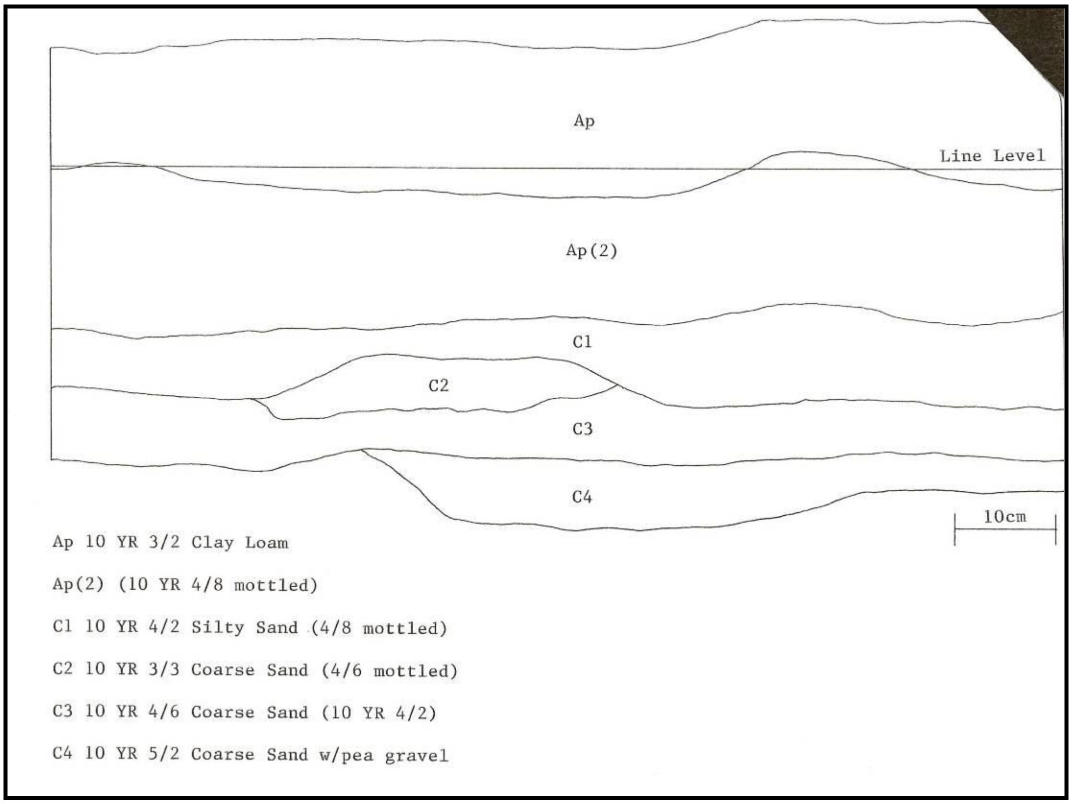

Figure 52. Profile of typical trench in Subsurface Area 25 (Zoll 1993).

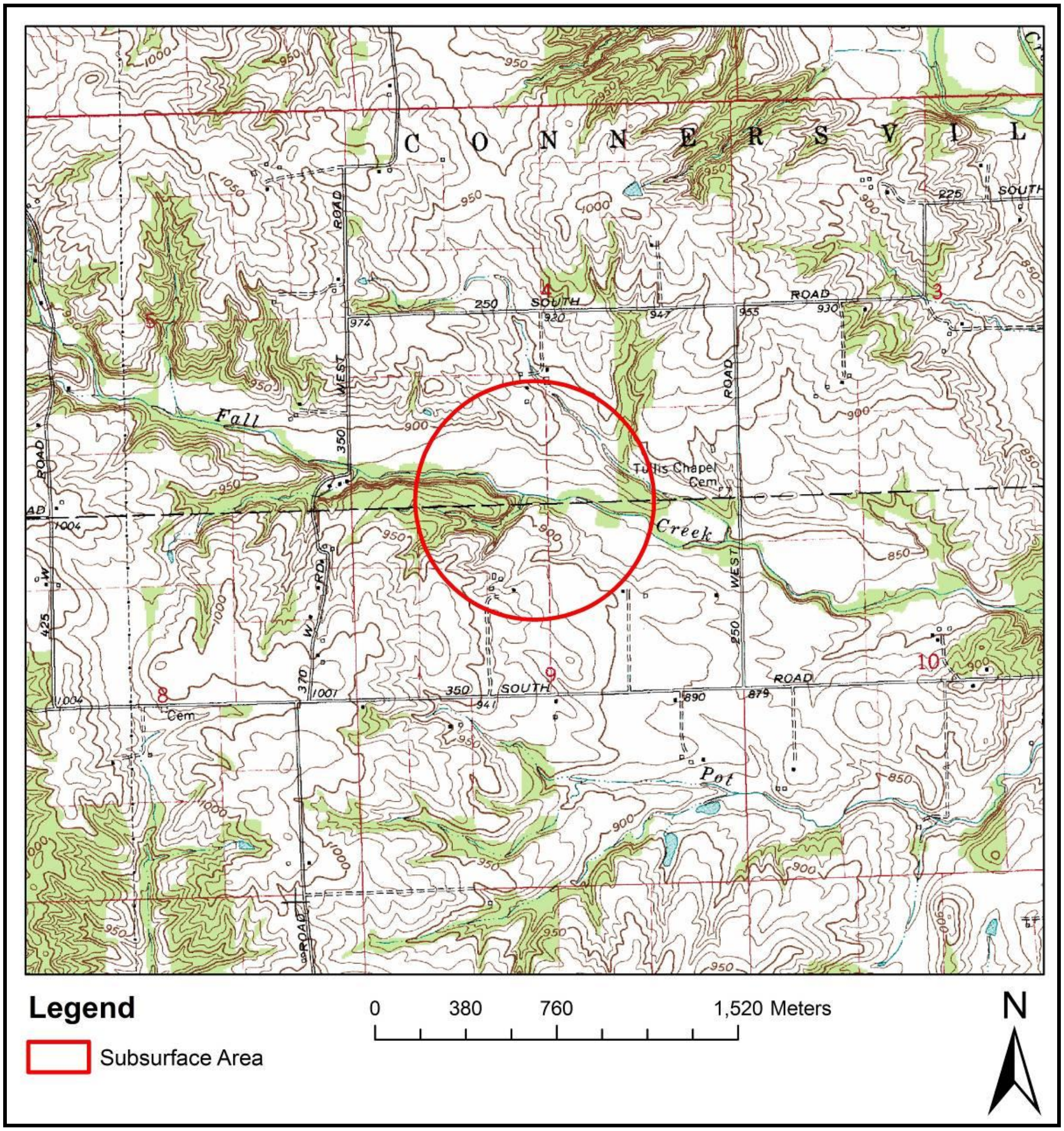

Figure 53. Subsurface Area 25 as shown on the USGS 7.5' series Alpine, Indiana quadrangle.

Investigation Area 26

Investigation area 26 is located in Franklin County (McCord 1994a). The original survey showed the potential for intact buried deposits. The soil within the project area is Gessie loam which is a competing series with the Genesee loams. A total of nine bucket augers were utilized to confirm the presence of well drained alluvium and a subsurface investigation was recommended (Stillwell 1992a). The subsurface reconnaissance was conducted right along the stream channel. A total of four trenches were excavated. The trenches within the project area revealed shallow alluvium over coarse gravel. A trench profile showing the sediments discovered is included below (Figure 45). The width of the stream valley at the location of the project area is 120 m (Figure 46).

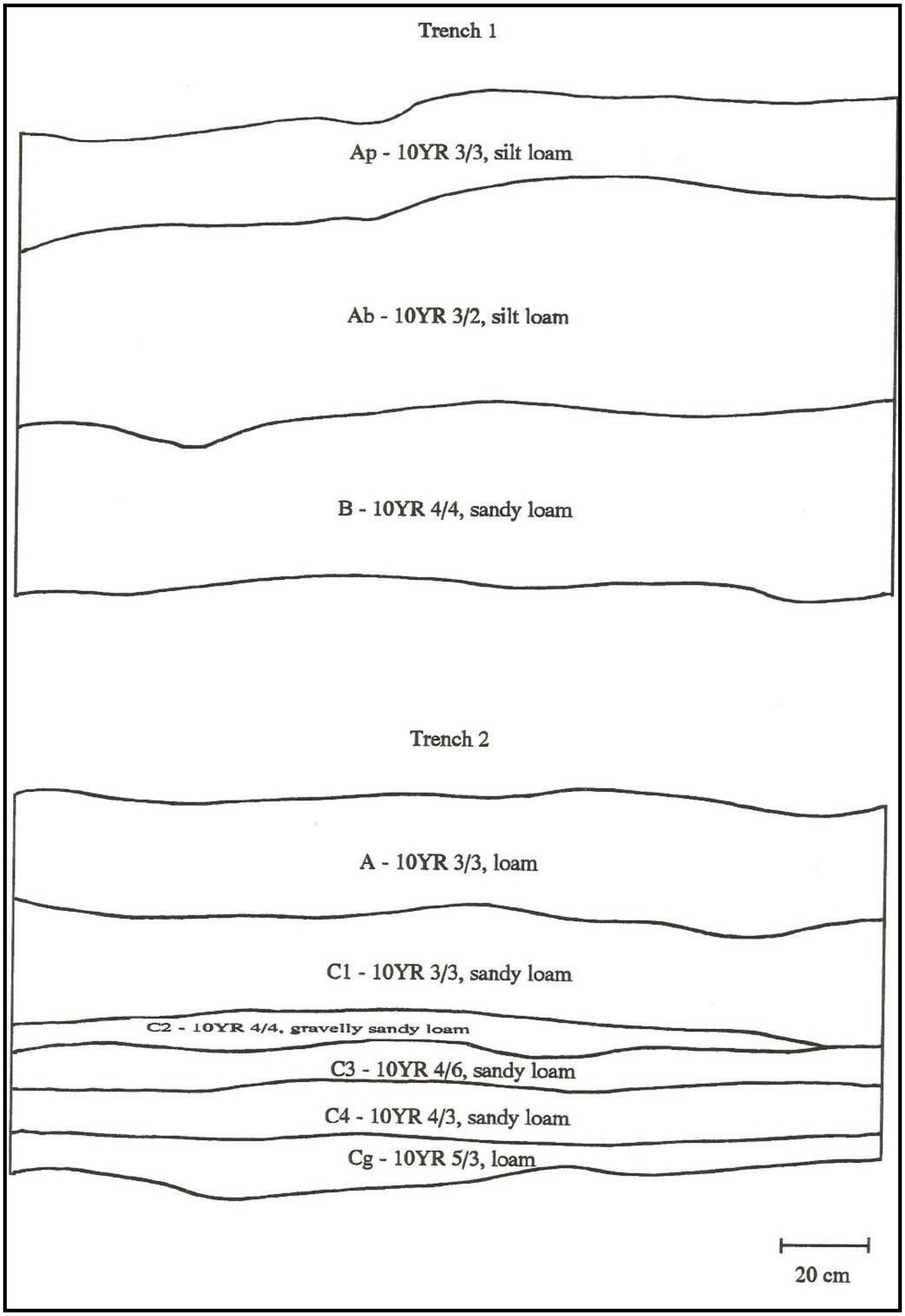

Figure 54. Profiles of typical trenches in Subsurface Area 26 (McCord 1994a).

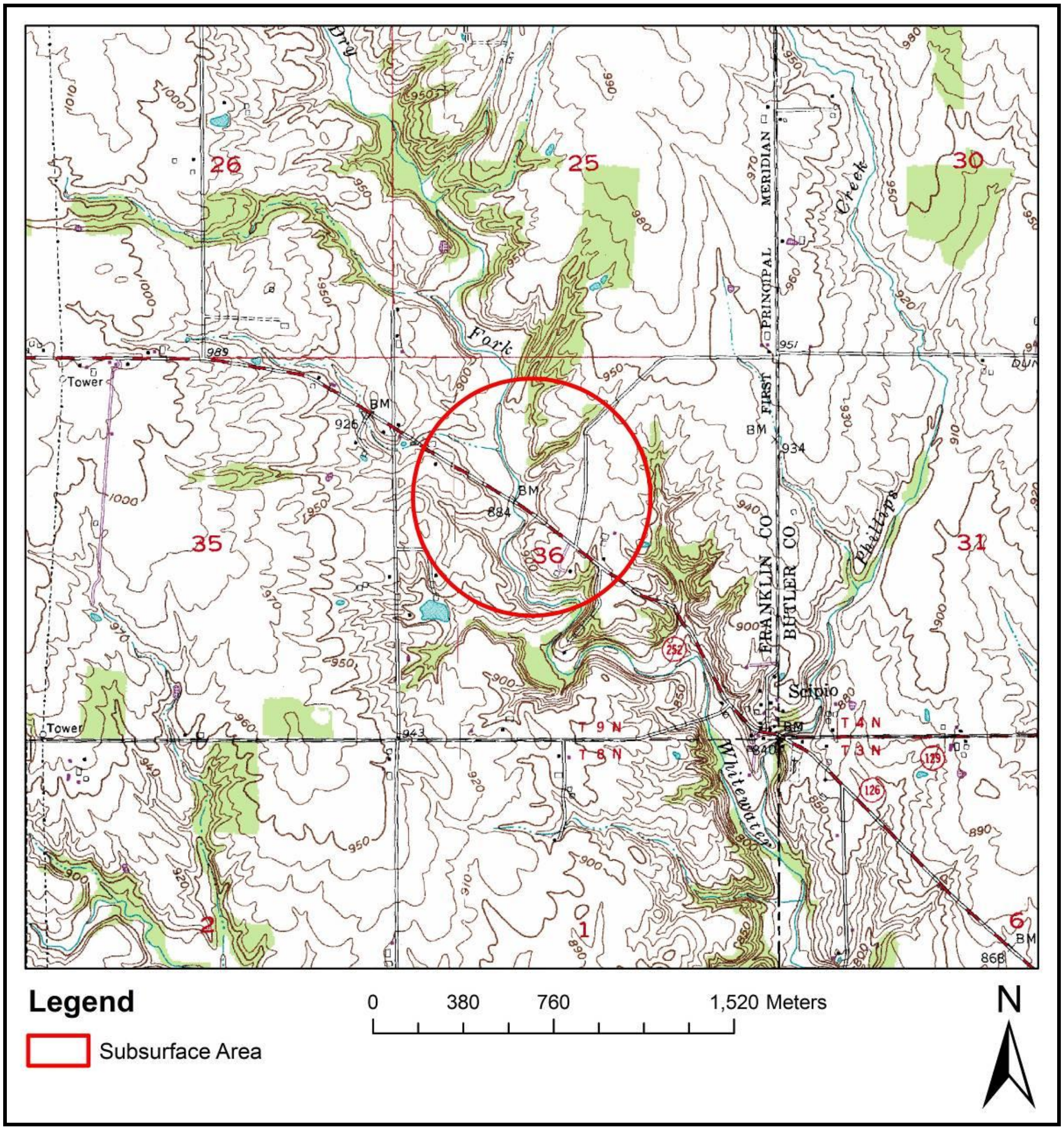

Figure 55. Subsurface Area 26 as shown on the USGS 7.5’ series Reily, Ohio quadrangle.

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PREDICTING BURIED SITES: ANALYSIS OF THE TIPTON TILL PLAIN REGION OF INDIANA.

APPENDIX B. GIS SOIL METADATA